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ABSTRACT

The Middle Grades Mathematics Project (MGMP) has been an effort to produce exemplary mathematics curriculum units for grades six, seven, and eight, evaluate the compatibility of those units in classrooms, and to study the nature of the effort needed to help teachers to teach the units effectively in their classrooms. Each activity designed by MGMP is intended to be taught using an instructional model based on three phases: launching, exploring and summarizing. Teaching the MGMP materials places demands on the teacher relative to both the content and to the instructional model. This study examines the impact of coaching as a strategy in changing teachers' instructional emphasis on producing the desired instructional changes. Changes in teachers' beliefs and behaviors included patterns of communication, teaching, planning for instruction and instructional thoughts and actions. Discussions include: (1) research questions; (2) theoretical framework; (3) methodology including development of instrument, observations, summer workshop, materials production and coaches; (4) the intervention; (5) results and discussions; and (6) conclusions and implications. Appendices include the study instruments and three case studies of teachers involved in the project: (1) a study of a lead coached teacher; (2) a study of a coached teacher; and (3) a study of an uncoached teacher. The study concludes that summer workshops were effective in assisting teachers with the MGMP units and that coaching is an effective strategy in promoting teacher change. (CW)

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THE MIDDLE GRADES MATHEMATICS PROJECT

THE CHALLENGE: GOOD MATHEMATICS--TAUGHT WELL

FINAL REPORT TO THE NATIONAL SCIENCE FOUNDATION FOR GRANT # MDR8316218

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The Challenge: Good Mathematics--Taught Well

INTRODUCTION

The Middle Grades Mathematics Project (MGMP) has been an effort beginning in 1977 to produce exemplary mathematics curriculum units for grades 6, 7, and 8, evaluate the compatibility of those units in classrooms, and to study the nature of the effort needed to help teachers to teach the units effectively in their classrooms. Five units have been produced and published under the titles of Probability, Similarity, Spatial Visualization, Factors and Multiples, and Mouse and Elephant. All of the units developed were written to be taught in a problem-solving mode using an activity approach, and often using concrete manipulative materials. Each activity is intended to be taught using an instructional model based on three phases: Launching, Exploring, and Summarizing (LES). These phases require different roles for the teacher and the students during instruction. Consequently, teaching the MGMP materials places demands on the teacher relative to both the content and to the instructional model. The MGMP units show the staff's concern for providing for both the students' needs and the teachers' needs. The detailed instructional guide provides help with both the content and, more importantly, with the translation of the content through a particular teaching model.

The reader needs to be aware that the conception of mathematics which should be taught to students in grades 6 through 8 and the manner in which that mathematics is taught is of special concern to the staff of MGMP.

Our goal is to have students achieve a deep understanding of a collection of related important mathematical concepts which serve as major foci in their cognitive knowledge of mathematics. It is important that the students encounter these concepts in diverse and multiple embodiments, that they see applications of those ideas in various ways, and that this deep understanding can only develop through time with repeated meaningful experiences with the ideas.

A linear, mastery level, lesson-a-day approach does not teach mathematics to students. They do not learn the nature of mathematics in that way. They do not learn how mathematics is created, why it is created, and how it can best be used.

The MGMP units with the instructional model embedded are an attempt to convey to the mathematics education community our conception of what we mean when we say, "Good Mathematics--Taught Well".

We think of mathematical knowledge as a connected network of nodes where each node is a collection of related concepts hovering around a particularly deep (or important) idea. The understanding of this knowledge is not sequential, nor predictable. Relationships are primary. The learner must be able to wander around through this rich network of ideas as though on a scavenger hunt, the way the practioners of mathematics do it.

This conception runs counter to most existing mathematics programs. Most programs focus on immediate mastery, drill and practice, and shallow understanding; avoid surprising applications; and settle for paper and pencil responses to predicable problems. There is no focus on big ideas; everything seems equally important.

We disagree. The students should know that ideas are primary--not procedures. It is much more important to know what fractions are than to be able to rotely compute with them. Most teachers also want to provide a meaningful experiences for their students in mathematics, but they are saddled with text series and curriculum guides which makes their task impossible.

In the hands of an excellent well-motivated teacher, an MGMP teachers' guide alone may be adequate to allow a faithful translation of the instructional model into a teacher's repertoire. This is not the case with most teachers. So the central questions becomes: How much and what kind of asssistance do teachers need or think they need to successfully teach a MGMP unit and further, to transfer the instructional model imbedded in the units to other appropriate parts of the regular curriculum?

Specific Knowledge Needed by Teachers

There is a lot of support in the literature for the position that teachers need specific knowledge of at least three kinds to be successful at helping their students understand the underlying concepts and processes of a particular topic: knowledge of content, knowledge of students, and knowledge of activities, e.g. Anderson and Smith (1983); Meyers (1981); Weiss (1978); Damarin (1981).

Knowledge of Content

Many students view mathematics as an endless string of isolated, unrelated, equally important facts. In order for teachers to help students see that knowledge of a topic in mathematics is organized around certain underlying concepts and relations, the teacher must have a sound understanding of the topic and its application in a variety of settings that show this underlying structure. The teacher must also accept as the primary goal of instruction the development of student understanding of these basic concepts and processes and their relationship of their topic to others ideas in the curriculum.

Knowledge of Students

Teachers need to know how students typically respond to instruction in a certain topic. They need to be sensitive to the kinds of misunderstandings and naive strategies that students develop to handle mathematical ideas. For example, in dealing with the concept of similarity teachers need to know that many students use inappropriate addition strategies to test similarity in situations where the dimensions of figures are not easily divisible. This knowledge allows a teacher to probe student responses in such a way that the students' strategies are brought to light and examined for their deficiencies.

Knowledge of Activities

Teachers need help in using appropriate teaching strategies and classroom activities to make desired learning take place. To create a problem-solving atmosphere in a classroom, a teacher must be flexible and responsive to student input and inquiry. If one goal is to develop students' abilities to reason independently, then students must be put in situations where they have the responsibility to explore, discuss relevant evidence, and seek solutions to problems about which generalizations are possible. The teachers' role in asking appropriate questions during this activity process is vital to its success.

The detailed MGMP teacher guides were prepared to help provide these three kinds of information for the teacher. The mathematical content is explained in detail including background for the teachers on the goals for each activity and the unit as a whole. Students' typical wrong

responses are discussed in the Expected Responses columns of the guides. Suggestions are made to help handle student errors. Questions and extensions are provided for the teacher to ask to help establish a problem-solving orientation in the classroom. The summary phase of the model helps the teacher guide students to refine strategies and make inductive generalizations.

From the literature on research on implementation we see that changing teacher behaviors in the classroom is difficult. Attempts to implement new teaching strategies and models require extensive inservice work with teachers which may take the form of demonstration, practice, feedback, and some form of coaching for transfer. McLaughlin and Marsh (1978) noted findings of the Rand Change Agent study with respect to teacher training and support activities:

> The study found that well-conducted staff training and support activities, promoted implementation, promoted student gains, fostered teacher change, and enhanced the continuation of project methods and materials.
>
> Staff training activities were typically skill specific - instruction in how to carry out a new reading program or introduction to new mathematics materials.
>
> Staff-support activities are necessary to sustain the gains of how-to-do-it training. In particular, the study examined the contribution of classroom assistance by resource personnel, the use of outside consultants, project meetings, and teacher participation in project decisions. Taken together as a support strategy, these activities had a major positive effect on the percentage of project goals achieved and on student performance. (76-77)

According to the Rand Study, professional development aimed at changing experienced teachers' practices may need a level of personal involvement with the teachers in addition to providing exemplary mathematics materials.

Fullan and Pomfret (1977) provided a comprehensive review of research on curriculum and instruction implementation. They suggested that there are five dimensions of implementation in practice: changes in materials, structure, role/behavior, knowledge and understanding, and value internalization. The goals of implementation must include changing teachers' behaviors or roles in the classroom in such a way as to encourage the acquisition of student process goals. Teachers can implement new materials in the classroom at a surface level, so that the students learn the skills and "algorithms" of the content without developing deeper understanding of the concepts and processes inherent in the mathematics.

Good, a visiting scholar to the Institute of Research on Teaching at MSU and a professor at the University of Missouri at Columbia, said at an Institute for Research on Teaching colloquium, "Research has shown how difficult it is to be a good teacher. Changes in teaching must be incremental, carefully thought through, comprehensive, and consistent with the realities of classroom life if they are to be lasting and successful." He pointed out that his research with Grouws on mathematics instruction showed many teachers tend to emphasize computation, memorization and mechanics. But the students of teachers who emphasize conceptual understanding get higher achievement scores in mathematics. (Notes and News, 1984).

Howson (1979) says "If new materials are to be handled with understanding, then training is insufficient -- one can train teachers to handle a new learning system, yet to cope with difficulties which arise in its use, the teachers must be reeducated." Joyce and Showers (1981) hypothesize that a fully elaborated training system including theory, demonstration and practice and feedback generally will ensure skill acquisition on the part of the teachers. However, if transfer is to occur, they suggest that further help is needed and that "coaching" might provide this needed help. These two researchers conceive of transfer as occuring on two levels -- one in which the teacher is able to use a new skill or strategy exactly as learned and the other in which a teacher applies a new skill or strategy to different curriculum.

Showers (1983) reports a very promising study in which the notion of coaching is elaborated. Coaching was conceived in this study as a combination of several elements: the provision of companionship, the giving of technical feedback, and the analysis of application. Technical feedback is <u>not</u> general evaluation, but is information about the specific execution of relevant skills and strategies. In the context of coaching an opportunity is made to examine goals, curriculum, materials, and appropriate use of newly acquired skills and behaviors into other parts of curriculum.

Good and Brophy (1974) demonstrated the power of intensive observations and feedback for assisting teachers to alter certain kinds of behavior. Lanier (1983) used an intensive advisor strategy to change teacher behaviors in general mathematics classrooms. There are many similarities between the characteristics of an advisors' work and that of a "coach". Scheinfeld (1977) in his account of advisory work says:

> A teacher advisor works side by side with a teacher to form a partnership in which teacher and advisor work together and with the children in the classroom. Together they develop curriculum, alter physical space, create new classroom organization and explore new kinds of teaching/learning relationships. (p. 2).

Andreae (1972) emphasizes that the advisor's role is to provide assistance in terms of teacher's needs. Apelman (1981) says that "stimulating and extending teachers' thinking about their goals raises advising above merely technical aid." An advisor's ultimate task is to elicit in the teacher a problem-solving and reflective attitude, that will enable him/her to overcome successfully future challenges. Incorporating the strengths of the advisory role with the more behavioral coaching role seems to be a very profitable direction in teacher inservice.

THE RESEARCH QUESTIONS

Previous work with implementation of the MGMP exemplary units had shown, as the literature predicts, that the materials alone did not produce the desired changes in teachers beliefs and practices in the classroom. This study examines the impact of classroom consultation (referred to as coaching) on producing the desired instructional changes. The major question is "How effective is coaching as a strategy in changing teachers' instructional emphasis from a computational to a conceptual orientation as reflected in the exemplary mathematical materials (MGMP units)?"

The staff identified changes in teacher practices that need to occur in order to implement effectively the LES model. These changes in teachers' beliefs and behaviors include the following major areas:

1) Patterns of Communication;
   The teachers need to ask more open-ended questions, require students to justify their answers, become aware of how the students are thinking about the mathematics, focus on questions that are more conceptually oriented, and reduce questions that are solely used to keep students on task.

2) Teaching
   The teachers need to use more non-examples, concrete manipulatives, and richer discussions in their direct instruction. They need to become aware of the conceptual breakdowns in their students' thinking and find ways to help students find ways to make sense of mathematical problems. They also need to help students make linkages between mathematical ideasand between mathematics and areas outside mathematics to which mathematics can be applied. Finally, the teachers need to create a fuller

class period with less down time and more time spent on mathematical activities and problem solving.

3) Planning for Instruction;
The teachers need to use concrete well-crafted lessons that reflect the LES Instructional Model. Their emphasis needs to be more conceptually focused with more time given to the development of mathematical concepts and making linkages between mathematical ideas (e.g. the part-to-whole relationship in fractions, decimals and percents). In addition, the teachers need to incorporate student groups, pairs, and individual exercises in their planning. Problem solving and challenging activities should be embedded in their instruction.

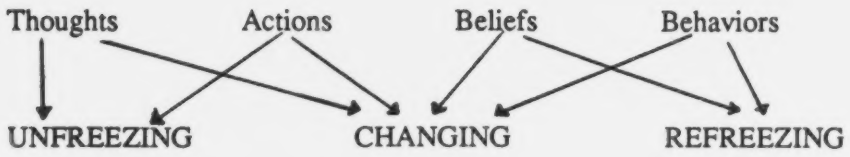
4) Instructional Thoughts and Actions.
The teachers need to take more responsibility for their students' learning, be more reflective in their teaching, and take more responsibility for their mathematical curriculum.

They also need to have a greater consciousness of the appropriate use of the LES model and not to see the MGMP units as add-ons to their curriculum. The teachers need to come to see the value of engaging the students in mathematical explorations as well as to push them toward generalizations. Most of all the teachers need to take the time to teach.

With the MGMP units and an elaboration of the needed change in hand the central question becomes, "How much and what kind of assistance do teachers need or think they need to teach successfully an MGMP unit and further, to transfer the instructional model imbedded in the units to other appropriate parts of the curriculum?"

THE THEORETICAL FRAME

The model of teacher change that the staff theorized would be found is based on Lewin's general model for the change process. As Blanchard (1981) explained, the Lewin model consisted of three phases: The first phase, unfreezing, prepared or motivated people for change; the second, the changing phase, took place when people learned new patterns of behavior; the third phase, refreezing, was the process by which the newly acquired behavior was adapted or integrated into the individuals repretoire. We imposed a series of changes on this model that we conjectured teachers would move through in varying degrees as they went through the three phases of change.



We conjectured that the first stage of teachers' change would be in the way they thought and talked about classroom instruction related to the project goals. This would be characterized by such things as using the project language without any real understanding and/or belief. This would be followed by a change in the teacher's actions in the classroom. These actions would be at a surface level. For example, teachers' might simply try increasing wait time, putting students physically in groups, or asking more questions. As the teacher began to move from thinking to believing that a conceptual focus has a payoff for students in learning mathematics, we expected to see a change in the behaviors that are more comprehensive than mere changes in acting. The teacher would then be able to provide a purpose for group work which would be communicated to the students. A teacher would not simply ask more questions, but the quality of the questions and the response encouraged from students would be more conceptually focused.

METHODOLOGY

The research question focused on the question of the differential effects of follow-up coaching on teachers who have had an intensive workshop training experience. The goal of the intervention was for teachers to experience a new instructional model and to internalize the model to the extent that they could transfer the model beyond the examples provided by the training.

The twelve teachers recruited for the first year of the project were divided into three groups. Four teachers comprise the uncoached group; four, the coached group and the coached lead group. The latter four teachers were to be worked with over two years. The goal was to help these four become effective lead teachers within their own schools. During the second year each of these four lead teachers were to train and coach at least one other teacher in their building.

Recruitment

In the development and evaluation of the MGMP Units, 1980-1983, the closest school districts

to the University were used extensively. These districts included East Lansing, Okemos, Haslett, Holt, Waverly and two Lansing middle schools. In order to be sure that we were working with teachers who were naive relative to MGMP, we moved out another layer of school districts from the University.

Contacts were made with the Superintendents of school districts in the target area. In Shiawasee County the Intermediate School District Mathematics Coordinator organized a meeting of teams of administrators and seventh grade teachers from all the school districts in the country. At this meeting, Lappan presented an overview of the materials and the research project. Five school districts expressed their desire to be involved in the research project. One district, at some distance from MSU, was asked to wait for the next year's group when the project would attempt to recruit additional teachers in the district's area so that travel in that direction would be cost efficient. The four other districts were accepted into the project.

Another five school districts were recruited through individual contacts. In the case of the recruited Lansing school, a formal proposal had to be submitted to the Lansing School District's evaluation office to obtain permission to contact particular school principals and teachers. In every case, after initial interest was expressed on the part of the school administrators, Lappan or Fitzgerald met with teachers and the principal in each school to explain the research in detail and to answer questions. Out of all this effort nine schools with 16 seventh grade teachers were recruited. In June, just before the summer workshop, we lost one school district with three teachers because of a last minute policy change on the part of the administration. The administration decided that the middle school would teach algebra in eighth grade. The three teachers felt that they could not be under pressure from two directions and withdrew from our project. We also lost one teacher who got pregnant. This left us with 12 teachers for the first year. This has turned out to be an ideal number because of the labor intensity of the coaching and the observational data collection.

Development of Instruments

Four instruments to measure change were developed by the staff during the first three and a half months of the project. The standard procedure used was for a subgroup of the staff to develop a draft of the instrument. In full staff meetings these were carefully considered. Suggestions for revision

were made and the subgroup produced a second draft. The full staff then as a group went over the instrument in detail before a third draft was produced. These drafts were tried out with teachers or students in classrooms as determined by the nature of the instrument. Revisions followed. This procedure was repeated until a satisfactory instrument was produced. Copies of all the instruments are included in Appendix A.

Each of the four instruments was based on similar type instruments that had been developed and used in other research projects. The Confidence Scales designed to evaluate the effectiveness of the summer workshop were based on similar scales developed in an NSF funded Honors Teacher Workshop directed by William Fitzgerald at MSU in November-December 1984.

The Student Inventory was designed to try to pick up student perceptions of the teacher's instructional model(s). It also asks questions trying to capture the student's view of the focus on the teacher--computational or conceptual. The way the teacher provides help to students who have questions is probed.

The Teacher Inventory probes the teacher's thoughts about questioning, instructional strategies, skills versus conceptual goals, use of manipulatives, grouping, etc. and collects data on teacher background.

The Teacher Interview was designed to probe teacher's beliefs in more depth at various stages over the entire project. This project made the early decision that gathering the observational data by graduate students hired by the hour to take field notes and do a checklist was not sufficient for our goals. We wanted the observers to be experienced field researchers, knowledgeable about mathematics, and teaching mathematics, trained to view the complexities of the classroom through the lens of MGMP and its instructional model. The observers in our project are being asked to take field notes showing teacher performance relative to the observer system, but also, to write high inference summaries which can only be done by a trained observer seeing the classroom over time. This is an expensive way to gather the data, since each observer was hired half time on the project. In order to stretch the budget to do things in this much more meaningful way, the director had to negotiate support and released time from her chairman and her dean. Both the cost of data collection and the labor intensity of coaching influenced the project's decisions for the last year of the project. Fewer

teachers were added and the first year cadre remained the subjects of major focus.

Baseline Data

In addition to three baseline observations in each participating teacher's class, the students in the classes were given a survey to determine their "picture" of the teacher's operating style and instructional model(s) in the mathematics classroom. These student surveys were given again in the fall of 1985 and were repeated at the end of the year 1985-86 and 86-87 school years.

The teachers were asked to respond to a teacher survey which asked about the teacher's goals, instructional model, homework policies, etc. These surveys were repeated at the end of the first and second years.

Classroom Observation

Classroom observation was selected as one of the research methods used in this study for two reasons: to describe teachers' classroom instructional behavior in general; and more specifically, to provide information about how teachers implemented the LES Instructional Model in their classes. Observations supplied researchers with knowledge about classroom instruction or teacher action that was clearly different than that obtained from the classroom surveys or the teacher interviews. Student and teacher responses to survey questions represented their perceptions of the classroom and the teacher's instruction. Interviews, on the other hand, captured the teacher's thoughts and beliefs about learning and instruction. Only classroom observation gave researchers a view of the instructional behavior of the teachers and the effects of project-related activities on teacher action in the classroom. The triangulation of observational, survey, and interview methods was necessary in order to answer the questions driving the study. The following section describes the observational data and includes: (1) how the classes were observed; (2) who observed the classes; and (3) the observational reports written from the data which was collected.

(1) Observing the Classrooms:

Classroom observations focused on teacher behavior and the patterns of instructional activity. Since the research questions were related to the teachers' implementation of the LES Instructional Model, it was necessary that classroom observation focus on and reflect the various phases of the Model. The phases of the LES Instructional Model were described in Janet Shroyer's (1984) paper,

"The LES Instructional Model: Launch-Explore-Summarize."[1] This paper served as the theoretical foundation from which the LES Observational Procedure was developed. In brief, the following phases of the LES model are listed below:

Phase	Description
LAUNCH	This phase includes activities where students are introduced to new concepts and ideas, and are reviewed on necessary previously encountered ones.
EXPLORE	In this phase students work on the Major Challenge. It is the teacher's responsibility to monitor and facilitate the students' activities.
SUMMARIZE	This is when the students return to the whole class mode of instruction and the mathematical ideas of the major challenge are discussed and clarified.

Project researchers wanted to know if teachers could use the LES Instructional Model in their classroom instruction and the degree to which the Model could be successfully transferred to their teaching of other math content. In other words, researchers wanted to know the level of quality of these phases. For example, a teacher could include a launch phase in his/her instruction to introduce a topic (such as area) by simple telling the students or demonstrating for them the formula, A = L x W. On the other hand, a teacher could launch or introduce the same topic through an interesting and challenging problem or story that would engage all the students in the learning activity and focus attention on underlying concepts.

The baseline data included raw fieldnotes taken in the classes of the project teachers. These

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1 A paper presented at the Honors Teacher Workshop of Middle Grade Mathematics, November 27 to December 15, 1984. Director: William M. Fitzgerald. Department of Mathematics, Michigan State University, East Lansing, Michigan 48824. (NSF No. DPE-8317063)

fieldnotes were audio-recorded and then transcribed for analysis. The baseline observations were made in the late Spring, 1985. One math class of each project teacher was observed over 3 class periods: one period included the introduction of new content; a second period was one where regular instruction occurred: and the third period was a day where previously taught content was reviewed. The researchers believed these 3 different instructional activities reflected the framework of the LES Instructional Model and gave them a general overview of the teachers' instructional patterns. After the baseline observations were transcribed a brief baseline report was written for each teacher.

In the fall of 1985, the teachers taught the Probability Unit and Activities 6, 7, and 8 were observed and analyzed. Observations of the teaching of the activities across all 12 of the teachers provided researchers with a basis for making comparisons and drawing generalizations across individual teachers as well as across the 3 separate groups of teachers. After the Probability Unit the teachers selected and designed their own transfer task which they would teach. Although the content for these tasks varied from teacher to teacher, the main objective for the observers at this time was to note, describe, and capture the teachers' attempts to implement the LES Instructional Model in the planning and teaching of the content. During the teaching of the transfer-task the observers took fieldnotes, audio-recorded their observations, and wrote inferential summaries of their observations.

(2) The Observers:

The project's observers have had extensive experience and training in ethnographic research methods. They have worked on research projects as classroom observers and have coded and analyzed data related to their observations. The observers were also familiar with the techniques of audio-recording their fieldnotes. Their previous experiences with observing meant that little time needed to be spent in training newcomers in the methods of classroom observation and the taking of fieldnotes. Prior to the gathering of the baseline data, the observers were trained by Nason in the procedures and concerns for this particular project. When the baseline observations were completed the observers reviewed and difficulties they had encountered. At this meeting they discussed and developed a set of conventions which provided consistency in the gathering of the data across observations and observers.

The observers attended parts of the 1985 MGMP Summer Teacher Workshop with the staff of

researchers and teachers in order to become familiar with the MGMP Units which would be taught during the coming year and to review the LES Instructional Model.

In early Fall, 1985, before observing the project teachers teaching the Probability Unit, the observers met to establish reliability for the observing of teacher behavior and instructional activity. The four observers took fieldnotes in an algebra class (non-project teacher) for two separate periods. They audio-recorded and then transcribed their observations. When this task was completed, they met and compared their results. Comparing the transcribed notes gave the observers further experiences in the rating of various instructional phases and helped to unify their thinking about the quality of the instructional phases and teacher behaviors.

(3) The Observers Reports:

During the period 1985-86 the observers wrote 2 documents on each of their assigned teachers. The first document was a baseline report which emphasized the teacher's classroom instruction prior to their project-related activities. This report included a description of the typical flow of class activity, the teacher's instructional patterns, the teacher's strengths and weaknesses as judged by the observer, and any other conjectures or opinions the observer deemed important. The baseline reports served as the first portraits of the teachers and their instruction before the project's interventions.

The second observational document for each teacher was written at the completion of the first transfer-task. This document provided a summation of the classroom observations of the Probability Unit and the first transfer-task. The report included descriptions of the flow of classroom activity, and inferential summaries, views of the teacher's instructional changes or strengths and weaknesses during this period. As with the baseline document, this served as an interim portrait of the teacher's classroom instruction and behavior.

The observer's summaries and the transcribed observations were combined with the teacher interviews, classroom surveys, and coaching documents and analyzed by the research staff with respect to answering the project's research questions.

The Summer Workshop

The first Summer Workshop for all twelve teachers was held in a middle school near MSU.

Forty rising seventh and eighth grade students were recruited to participate in the Summer Workshop. These students came from the local area and from the schools of the participating teachers. Care was taken to ensure that no students involved in the summer program would be in the target classes in the fall.

The Workshop was of two weeks' duration. On Monday, the first day, the twelve teachers were given an overview of the mathematics in the two MGMP units to be used in the research project. The nine remaining days had the following general form: From 8:30 AM to 9:30 AM, the students were divided into two groups to study the Similarity Unit. From 9:30-10:30, the students studied the Probability unit. Four staff members taught the four classes. The twelve teachers were rearranged each day in such a way that they got to see each unit being taught by two different staff members. After the students left, the staff and the twelve teachers met until 1 PM each day analyzing the lessons. Research readings were given to the teachers to help focus their observations on critical aspects of the instructional model being demonstrated in the classes. Pacing, questioning techniques, wait time, use of groups in instruction, problem solving, patterning, making generalizations, the role of manipulatives and teaching for deep understanding were some of the issues considered.

On Thursday of week one, a staff member gave the first specific, detailed description of the instructional model. By this time the teachers had seen six lessons being taught by the staff. On Friday the teachers were divided into groups of three, given an article from the Arithmetic Teacher on predicting the number of factors of a given number, and asked to try to write a lesson using the instructional model centered on the mathematics ideas in the article. These were collected at the end of the session on Monday. The teachers were provided very specific feedback on their efforts. This exercise was a practice for the transfer tasks to be attempted after each unit during the school year.

To determine the effectiveness of the two-week workshop in increasing teachers' knowledge and confidence in their ability to teach the units, a confidence scale was administered pre and post workshop to the twelve teachers. The Confidence Scale comprised questions from the Probability and Similarity Units. The teachers were asked to consider each of 20 questions and to rate first their confidence in their ability to solve the question, then their confidence in their ability to teach the mathematics of the question, and then finally were asked to actually solve the problems. Examination

of this data shows that the workshop was very effective at increasing teachers confidence in dealing with the mathematics of the two units. In addition, the analysis shows that within each of the three groups--coached, uncoached, and lead teachers--there is similar variation in background and in response to the workshop. One difference is that the four lead teachers were younger in their careers than either of the other groups. There were, however, both elementary and secondary trained teachers in each of the three groups.

The staff has become doubly convinced that the opportunity for teachers to observe others teaching children is invaluable. It seems to be a most effective way to help teachers see that children can think more deeply and creatively about mathematics than they had previously thought. One of our lead teachers revealed her thoughts on this subject in a coaching session when she said, "You know, you have to have teachers see this being taught. If they don't, they will look at the material, see the fractions and say 'My kids's can't do this!' I was even surprised at what the kids could do."

Materials Production

During August, when the demand on the Mathematics Department's copy machine was low, student materials for Probability were copied for each teacher. Teachers were provided with materials for as many classes as they wished. Most of them chose to try the materials in all their mathematics classes. The equipment needed--dice, spinners, ping pong balls, etc.--were also provided. Materials and equipment were delivered in early September to all twelve teachers.

Student materials and equipment for the Similarity Unit were also produced. These were finished during Christmas Holidays when the copy machine is available and delivered to schools in mid-January. This cycle of production was repeated the second year for the enlarged group of teachers.

Coaches

During the school years 1985-86, and 86-87 the staff of four coached eight teachers in six different school districts all within a radius of 40 miles of MSU. As the staff developed more specific plans for coaching, it became clear that in order to be able to make significant, useful suggestions and to follow through with the teacher on these, the coaches must be present virtually every day during the intensive phase: practice units and transfer tasks. Consequently, the staff visited their teachers

15-25 times during each cycle (unit plus transfer task) of the first year intervention, and somewhat fewer times during each cycle the second year.

Data was collected by the trained observers during the teaching of Activities 6, 7, and 8 of the Probability and Activities 2, 3, and 4 of the Similarity. This usually meant five days of field data collection per unit. The transfer tasks include another 3-5 days of data collection for each.

Each of the coaching situations obviously involved different personalities and different school environments. Yet, in every situation the teachers and coaches established a good working relationship. Every situation must of necessity have its own agenda since the strengths and weaknesses of the teachers relative to the instructional model differ. However, the staff met each Monday afternoon to give an update on successes and problems in each coaching situation. Through this dialogue the staff was able to keep itself focused on the goal of the coaching--to help the teachers internalize the instructional model and be able to use it effectively in their classrooms.

In most situations the coaches were able to observe a teacher's class for a period and immediately afterwards have a coaching session during the teacher's planning period. In situations where this was impossible, the coaching sessions took place after school or over the telephone. Teachers were given written notes of the coach's observations to read and help focus the coaching sessions.

The four uncoached teachers were located in two schools--three in one and one in another. These teachers were visited once in the fall by staff members. The staff member's visit was to listen to the teachers talk about teaching the first unit. The reason for these visits was to help these teachers feel a part of the project and to counter the Hawthorne effect on the coached teachers. Obviously, they were also observed by the field data collectors for the same activities as the coached teachers.

As the project developed over the first year, it became clear that a great deal of useful information in answering our research questions would be lost if we did not follow some of the coached and uncoached teachers through another school year. Consequently, we decided to recruit only eight new teachers, for the year 1986-87. In addition we asked the first year teachers to continue for another year. The only teacher who withdrew did so for medical reasons.

At the end of the project we have complete data on 17 of the 20 teachers. On 11 of the 20, we

collected data over a two year period.

THE INTERVENTION

The MGMP intervention was designed to provide an opportunity to study implementation of the instructional model imbedded in the exemplary units which were developed in an earlier curriculum development phase. The parts of the intervention were constructed to create opportunities for teachers to consider a broad spectrum of constraints to instructional change. The project was, in particular, informed by three pieces of work: (1) Lewin's model of change (Branchard, 1981)

unfreezing ⟶ changing ⟶ refreezing,

(2) Joyce and Showers (1981, 1983) theory that staff development must include demonstration, practice, feedback and coaching for transfer, and (3) Shulman's model of pedagogical reasoning and action (Shulman, 1987). An outline of each of these works is given below.

The Change Process Lewin	Levels of Impact of Teacher Development Joyce and Showers	A Model of Pedagogical Reasoning and Action Shulman
Unfreezing	Awareness	Comprehension
The aim of unfreezing is to motivate and make the individual ready to change. It is a thawing out process through which the forces acting on individuals are rearranged so that they now see the need for change.	The importance of an area is realized and one begins to focus on it.	Teachers are expected to understand what they teach, and when possible, to understand it in more than a single way. They understand how a given idea relates to other ideas within the same subject area and to ideas in other subjects as well. Comprehension of purposes is also central.

The Change Process
Lewin

Changing

Once individuals have become motivated to change, they are ready to learn new patterns of behavior. This process is most likely to occur through two mechanisms: identification and internalization.

Refreezing

The process by which the newly acquired behavior comes to be integrated as patterned behavior into the individual's personality or ongoing significant relationships is referred to as refreezing.

Levels of Impact of Teacher Development
Joyce and Showers

Concepts and Organized Knowledge

Concepts provide intellectual control over relevant content.

Essential to inductive teaching are knowledge of inductive processes,

how learners at various levels of cognitive development respond to inductive teaching, and knowledge about concept formation.

Principles and Skills

Principles and skills are tools for action. At this level one learns the skills of inductive teaching.

At this level there is the potential for action--one is aware of the area, can think effectively about it, and possess the skills to act.

Applications/Problem Solving

This is the transfer of concepts, principles, and skills to the classroom.

A Model of Pedagogical Reasoning and Action
Shulman

Transformation

Ideas must be transformed to be taught. The processes of transformation are: Critical intrepretation Representation, Instructional selections, and Adaption. One moves from personal comprehension to preparing for the comprehension of others.

Instruction

Instruction is the observable performance of the variety of teaching acts. It includes: organization and managing the classroom; presenting clear explanations and vivid descriptions; assigning and checking work; interacting

effectively through questions, probes, answers, reactions, praise, and criticism.

Evaluation

Includes both the on-line checking for understanding and misunderstandings during the activities of interactive teaching, as well as the more formal testing and evaluation used to provide feedback and grades.

It is also directed at one's own teaching.

Reflection

A looking back at the teaching and learning that has occurred and a reconstructing, re-enacting and/or recapturing of the events, the emotions and the accomplishments.

It is the processes through which a professional learns from experience.

The Change Process Lewin	Levels of Impact of Teacher Development Joyce and Showers	A Model of Pedagogical Reasoning and Action Shulman
	One begins to use the teaching strategy that was learned, integrates it into one's style, and combines it with others in one's repertoire.	New Comprehension Through acts of teaching that are "reasoned" and "reasonable" the teacher achieves new comprehension, both of the purposes and of the subjects to be taught, and of the students and the processes of pedagogy themselves.

The components of the intervention, designed by MGMP staff, and the expected outcomes are outlined below. Remember that all teachers experienced all aspects of the intervention except coaching. Eight teachers were coached and two of these became peer coaches.

Phase	Component	Expected Outcome
Two week Summer Workshop	Overview of the two Exemplary Units (one day)	Improve content knowledge. Build confidence.
	Modeling the teaching of the units with classes of middle school students. (nine days)	Building confidence in knowledge of content and instructional model.
		Confront expectations of what students can do.
	Critiquing and discussing the lessons observed.	Learn to observe and to listen to students to monitor their cognitive development.
		Consider the quality of communication: the effects of questions asked and student responses and the teacher's responses to student questions.
		Observe the quality of communication and intellectual engage of students during group work.
	Seminar on the Instructional Model (one day)	Shift the focus from content knowledge to pedagogical knowledge and the interaction of the two.

Phase	Component	Expected Outcome
		Clarify what each of the three phases of a lesson in a unit are designed to accomplish.
		Clarify the teachers role during each phase of a lesson.
		Consider what types of content and mathematical goals are appropriate when choosing to use this model.
	Designing a Transfer Unit	Confronting the model in a constructive rather than passive role.
		Build deeper understanding of the model and the role of the teacher.
		Focus on constructing good exploratory tasks to engage students in making conjectures about mathematical situations.
		Design good questions which will provoke deep thinking in the students.
	Readings	Provide support for the kind of changes in mathematical goals and instructional strategies advocated by MGMP.
		Deepen and broaden teachers, thinking about mathematics and the teaching and learning of mathematics.
		Provoke dissonance within teachers as they consider their beliefs and practices.
Academic Year: two cycles each consisting of an MGMP Unit and a transfer Task.	Teaching an MGMP Unit	Practice using the model in a situation where the planning for management, the mathematical goal setting, and the questioning sequences are provided by the unit. Experience success in using the model.

Phase	Component	Expected Outcome
		Build confidence in both the mathematical content and in teaching the content.
	Coaching	Continue to confront and evaluate their own beliefs and practices.
		Build deeper understanding of the instructional model.
		Learn to reflect on each lesson in a constructive way.
		Learn to evaluate the quality of communication in the classroom.
		Learn to ask questions which promote thinking and deep understanding.
		Learn to use questions and responses to assess student growth.
		Learn to give up some control to the students through using group explorations.
		Learn to guide without giving away "the answers."
		Focus on the conceptual development of the students.
	Teaching a Transfer Unit	Provide opportunity to transfer what has been learned from teaching an MGMP unit to another part of the curriculum.
		Deepen understanding of the instructional model.
		Practice planning and teaching for conceptual development rather than for developing computational or procedural skills.
	Coaching	Guidance in selecting appropriate content and goals for the transfer unit.

Phase	Component	Expected Outcome
		Guidance in developing approprate tasks and questions to reach the goals.
		Guidance in management and other aspects of teaching the unit.
		Continued modeling of the role of the teacher during exploration.
		Help with content knowledge.
		Help with learning from reflection.
		Help in establishing good planning habits.
		Encourage and support the teacher while he/she tries something new.
	Whole Group Pull Back Sessions	Build a network of support and collegiality.
		Provide additional content ideas and knowledge.
		Help the teachers examine the present middle school mathematics curriculum.
		Encourage them to look for relationships, to isolate the big ideas, and to build their programs around chunks of related ideas that will enable students to use their mathematical knowledge more flexibly.
	Professional Activity outside their own classrooms.	Begin to think of oneself as a professional
		Transform one's knowledge and experience in a way that will communicate an awareness and urgency for change in other teachers.

Phase	Component	Expected Outcome
		Make the teachers accountable for their beliefs and practices.
		Solidify knowledge.
		Build confidence.
		Expand network and collegiality.
		Experience coaching a peer.

This sequence of activity was repeated each of the two years of the project. (See Table 1.) There were some changes in focus and intensity from one year to the next. The first summer observations were more global in nature and the first year's coaching was very intense. The second summer the observations were focused on the cognitive development of individual students and the practice in designing a transfer unit was intensified. During the second academic year the coaching was less intense and some teachers began peer coaching.

Table 1- Intervention Outline

1985-1986

June	First Semester		Second Semester		
Two-week Summer Training Workshop	MGMP Probability Unit	Transfer Task I	MGMP Similarity Unit	Transfer Task II	Pull Back Session

1986-1987

June	First Semester		Second Semester		
Two-week Summer Training Workshop	MGMP Unit	Transfer Task (Fractions) III	MGMP Unit Session	Transfer Task IV	Pull Back Session

RESULTS AND DISCUSSION

Summer Workshop. The Confidence Scales

To assess the change in confidence fostered by the Summer Workshop, participants were given a set of 20 mathematics problems that represented the big ideas in the two MGMP units that were to be taught by the participants in their own classes. They were asked to rate each problem on a scale of 1 to 5 (high) according to their confidence that they could solve the problem. Then they were asked to rate each problem according to their confidence that they could teach the mathematics in the problem. Finally they were asked to solve the problems. These scales were administered pre- and post- for the summer workshop.

Overall the data shows that the summer workshop was very successful. The activities gave the teachers strong support for confidence and knowledge building over the two weeks of the summer workshop. Whether we look at the total group or at each of the three subgroups the picture is very similar. There was a significant change (at the .001 level) in the level of performance and confidence in solving and teaching pre to post (see Table 2). As one would expect there are significant correlations between confidence in solving pre- and each of the three post measures. This indicates the importance of confidence in one's mathematical knowledge if one is to be confident in one's teaching (see Table 3). Table 4 shows the total and three subgroups means on each aspect of the scale. Groups 1 and 2 were quite similar with group 3 slightly weaker. The Probability questions were perceived of by all groups as harder and no group reached 100% performance at the end. The similarity questions were easier and all groups reached 100% performance at the end. These same data are presented in graphical form in Figures 1, 2, and 3.

The summer workshop is a confidence building experience for the teachers. Confidence in solving exceeds both confidence in teaching and prorated actual performance in all groups. The difference in the two units (probability and similarity) in confidence levels and actual performance over all groups was striking. All groups finished at the top of the scales on similarity questions. However, the results in the probability questions showed that the teachers needed continued help in building confidence and knowledge in teaching the probability unit.

Table 2 - 20 mathematical tasks - Participant mean scores and results of t-tests for pre-post workshop differences

	Mean values		t	P<
	pre	post	value	
Level of performance[a]	16.67 (83%)	18.67 (93%)	3.806	0.001
Confidence in solving[b]	4.37	4.85	7.633	0.001
Confidence in teaching[b]	3.87	4.72	11.506	0.001

(a) 20 problems on a scale of 0/1 for wrong/right.
(b) on a scale of 1 to 5 (high).

Table 3 - Pearson correlation coefficients among level of performance, confidence in solving and confidence in teaching on the twenty MGMP questions.

	Conf in. solving pre (1)	Conf. in teaching pre (2)	Level of perfor. pre (3)	Conf. in solving post (4)	Conf. in teaching post (5)	Level of perfor. post (6)
(2)	0.569					
(3)	-0.253	-0.399				
(4)	** 0.786	0.420	-0.120			
(5)	** 0.799	*0.663	-0.219	**0.769		
(6)	*0.697	0.500	-0.056	*0.655	0.411	

* Significant at = 0.05

** Significant at = 0.01

Table 4 - Group mean scores

		All			group 1			group 2			group 3		
		S[a]	T[b]	P[c]	S	T	P	S	T	P	S	T	P
Total	Pre	4.37	3.87	16.67 (83%)	4.41	4.05	16.75 (84%)	4.51	3.86	16.25 (81%)	4.18	3.69	17.0 (85%)
	Post	4.85	4.72	18.67 (93%)	4.95	4.84	19.0 (95%)	4.88	4.79	19.0 (95%)	4.74	4.55	18.0 (90%)
Prob.	Pre	4.13	3.58	4.33 (62%)	4.07	3.68	4.25 (61%)	4.29	3.64	4.00 (57%)	4.04	3.43	4.75 (68%)
	Post	4.61	4.49	5.67 (81%)	4.86	4.68	6.00 (86%)	4.64	4.54	6.00 (86%)	4.32	4.25	5.00 (71%)
Sim.	Pre	4.49	4.04	12.08 (93%)	4.60	4.25	12.5 (96%)	4.63	4.02	11.5 (88%)	4.25	3.85	12.25 (94%)
	Post	4.99	4.85	13.0 (100%)	5.00	4.92	13.0 (100%)	5.00	4.92	13.0 (100%)	4.96	4.71	13.0 (100%)

(a) S - Confidence in Solving on a Scale of 1 to 5.
(b) T - Confidence in Teaching on a Scale of 1 to 5.
(c) P - Level of Performance in percents.

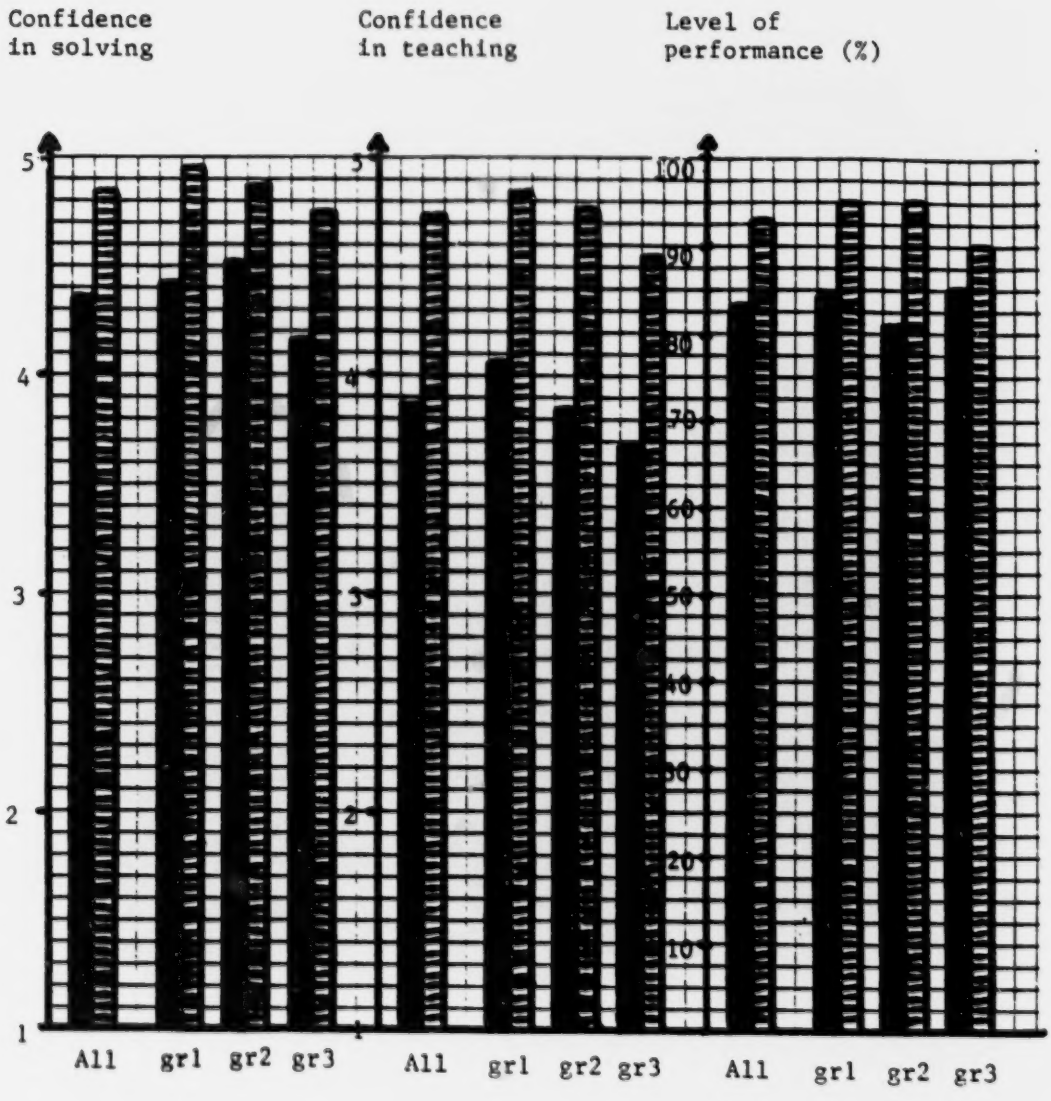


Figure 1. All 20 problems

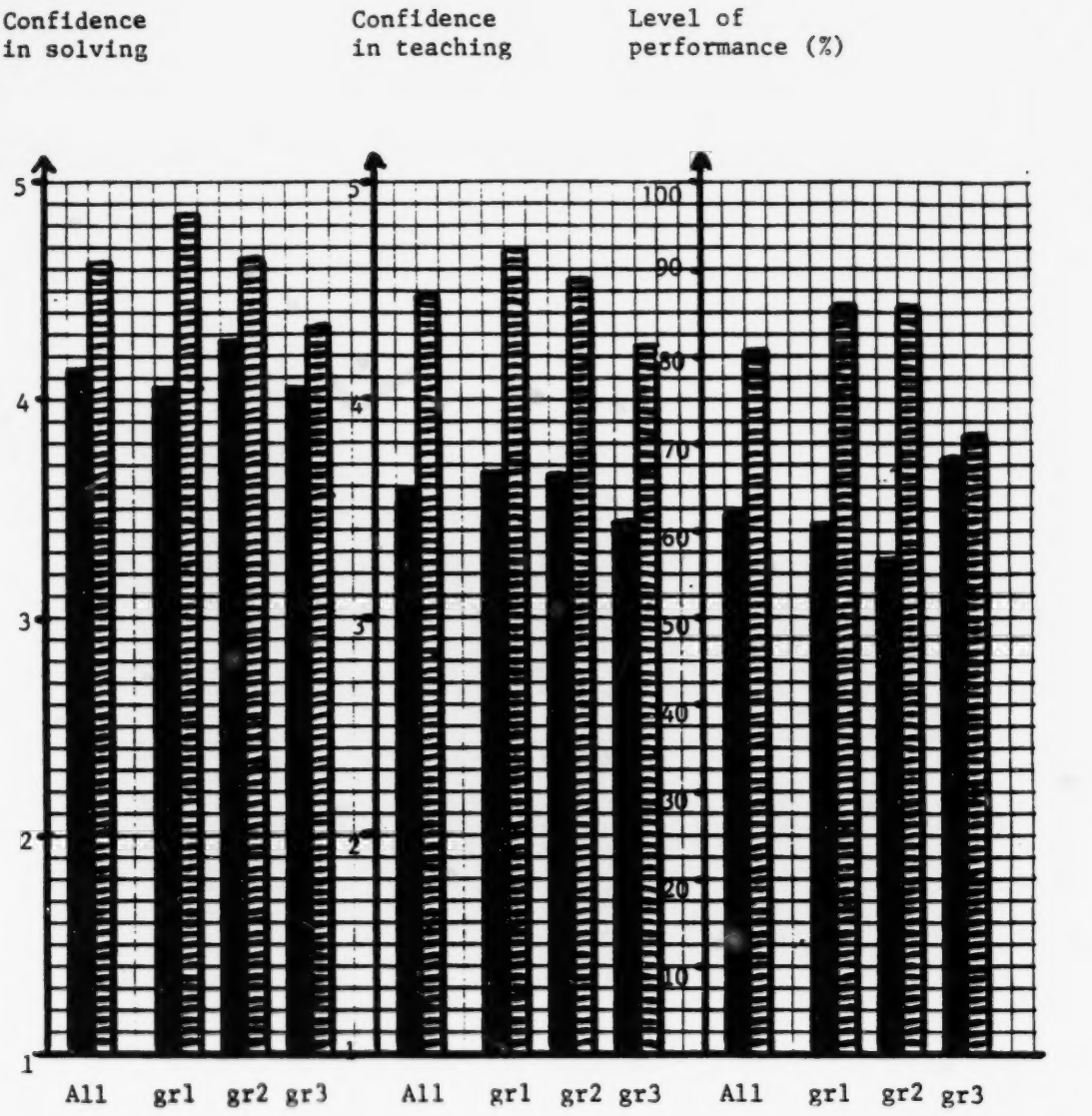


Figure 2. Probability - 7 problems

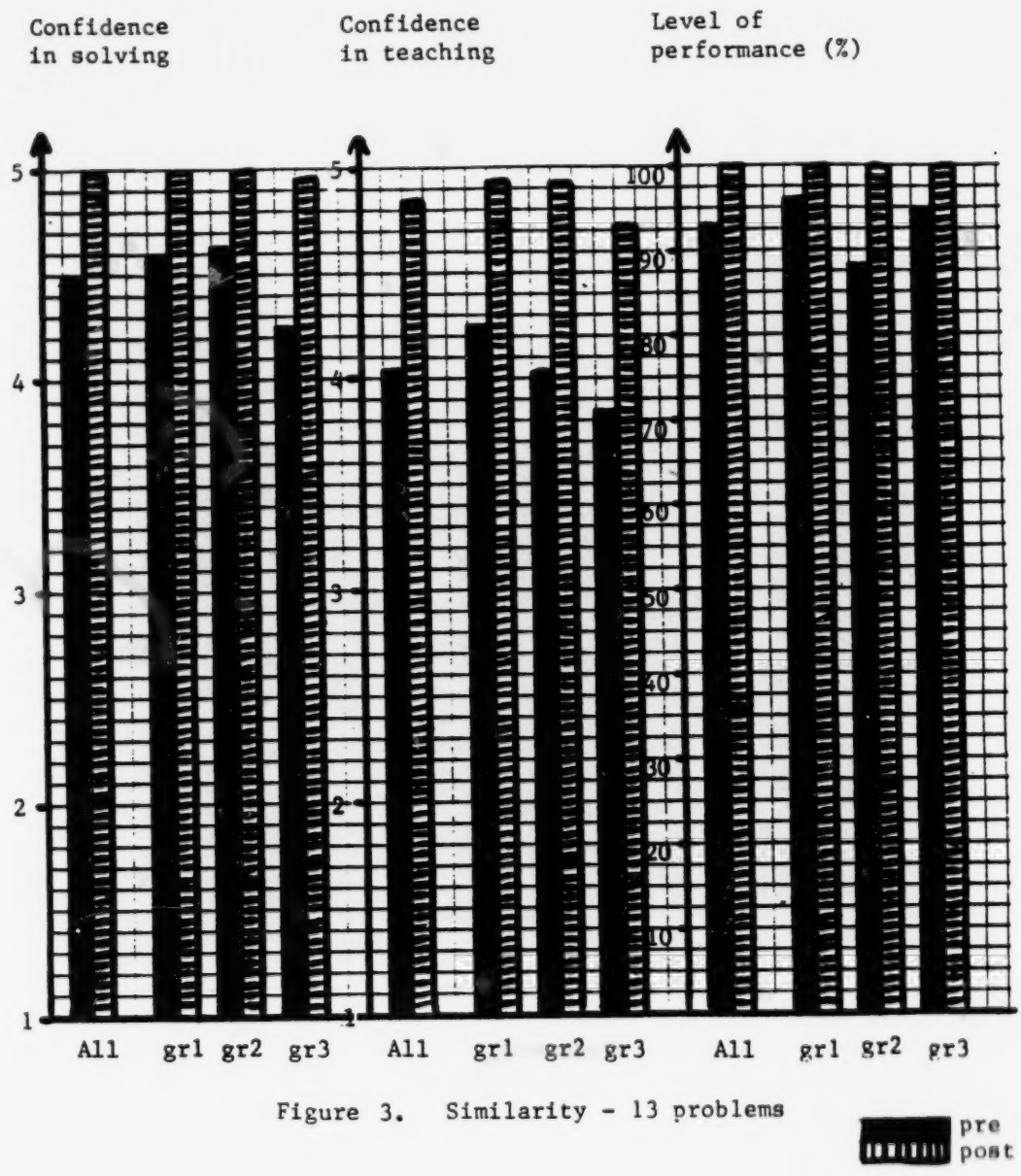


Figure 3. Similarity - 13 problems

The Teacher Style Inventory and Student Survey of the Classroom

In an effort to capture the changes in teacher's thoughts, actions, beliefs and behaviors surveys were administered to the project teachers and the students in their classes. The surveys used a Likert-scale requiring a response from 1 to 5. Students completed the Student Survey twice during the school year - once in the Fall and Spring. The teachers were given the Teaching Style Inventory at the start of the project, after the first year, and at the end of the second year. It was believed that the results of the Teaching Style Inventory across the two years would provide evidence of a teacher's changed perceptions about instruction and classroom practice. The results of the Student Survey would reflect a teachers' changed practices in the classroom from the student's perspective.

The Teaching Style Inventory consists of 4 sections with a total of 45 items. The survey is included in the appendix. Two sections (29 items) were used in the following analysis and include items such as:

11. In my math class I emphasize the basic computational skills three/fourths of the time or more. ____1 ____2 ____3
    In my math class I emphasize concept development three/fourths of the time or more. ____4 ____5

In addition, other items dealing with the strategies used in classroom instruction asked teachers to respond with very frequently, frequently, sometimes, seldom, and never. These items include:

20. Posing open-ended challenges.

21. Encouraging analysis and generalization.

The Student Survey of the Classroom consisted of a total of 26 items, 12 of which were selected as those most likely to capture the students perceptions of the changes of a teacher's actions. The survey is included in Appendix A. The students selected the following responses - never, seldom, 1/2 the time, usually, and always. Examples of these items include:

		never	seldom	Half the time	usually	always
3.	Does your math teacher encourage the class to find different ways to solve the same problem?	A	B	C	D	E
4.	When your math teacher asks a question, do you have time to think about the answer before you must reply?	A	B	C	D	E

The Teacher and Student Surveys from the Spring of 1985 (Pre-Project), the Spring of 1986 (Interim)

and Spring of 1987 (End) were analyzed. A method of analysis of these pre- and interim surveys was employed that captured the changes the teachers had made in their thinking and in their classroom practice. This analysis involved making a comparison between the "actual" response on a particular item with the "ideal" response for that item. For example, if a teacher or the students responded to an item with a 2 and the "ideal" response for that item was 5, a 3 was recorded. This value of 3 signified that the "actual" responses was 3 levels away from the "ideal". A sum of the distances of all the items from the "ideal" was calculated for each pre-, and interim, and post-survey for the tacher and for their classes (see tables 5, 6 and 7). The lower the value the closer the responses were to the "ideal". The difference between the sums on the pre-, and interim and then the pre- and post- surveys represented the Index of Change - or the amount of change that occured.

Table 5 - Pre- To Interim Results of the MGMP
Teacher Style Inventory and Student Survey of the Classroom

TEACHING STYLE INVENTORY				STUDENT CLASSROOM SURVEY			
Tchr Code	Spring '85	'86	Change	Tchr Code	Spring '85	'86	Change
A-1	53	36	-17	A-1	28.8	27.4	-1.4
A-2	61	36	-25	A-2	30.2	27.6	-2.6
A-3	62	53	-9	A-3	26.8	25.5	-1.3
A-4	53	22	-31	A-4	26.4	26.4	0.0
B-1	65	51	-14	B-1	27.7	23.1	-4.6
B-2	48	32	-16	B-2	27.0	23.4	-3.6
B-3	51	43	-8	B-3	27.0	21.4	-5.6
B-4	54	46	-8	B-4	28.0	24.3	-3.7
C-1	67	43	-8	C-1	26.1	22.1	-4.0
C-2	55	38	-17	C-2	24.1	22.5	-1.6
C-3	80	71	-9	C-3	27.8	26.8	-1.0
X	59	43		X	27.3	24.6	
SD	9.2	10.2		SD	0.51	2.13	

The results suggest that each of the project's teachers had made changes in thinking about instruction

and practice across this first year (Table 5). Interestingly, three of the four "lead" teachers ranked first, third and fourth in the Interim Teacher Survey results. This would indicate that these teachers had changed more in their thinking than did their project counterparts. Of additional interest are the results from the Student Surveys that indicated the students in the project teachers classes noticed some changes in their clasroom but this change was not substantial. The group of teachers whose students reported the greatest change across the year were the group of "coached" teachers - rather than the "lead" teachers. Although the "lead" teachers showed more change in their perceptions, their students did not see this change reflected in the teacher's practice classroom. On the other hand, the "coached" teachers showed less change in their perceptions, but their students indicated more of a change in these classes. The identification of a teacher as a "lead" teacher added a dimension to the coaching relationship that changed the focus of the coaching from the implementation of particular content and materials to a broader look at instructional practices. The "lead" teachers seemed to hold in mind their role of "coach" the following year as they reflected with their coaches on their classroom practices; perhaps looking forward to their roles as coaches.

The results of the first year indicate the teachers had changed their thoughts about instruction and had made some changes in their classroom practice. We speculated that the survey results from the second year would show more dramatic changes in the beliefs and behaviors of the "lead" and "coached" teachers and less change in those of the "uncoached" teachers.

Discussion and Emerging Conclusions of the Teacher Style Inventory and Student Survey

Over the first year the picture of each teacher gathered from the survey data fit the picture emerging from the coaching reports, interviews and observations. The teachers were changing - all 11 were moving in the desired direction - but at very different rates and ways. (One uncoached teacher dropped out of the study in January of the first year for medical reasons.) In general, the coaching which took place during the first year provided the teachers with vocabulary for communicating ideas and a frame for thinking about and reflecting on their instruction. (Several teachers reported they had imagined conversations with their coach when faced with resolving an instructional problem.) However, none of the project teachers reached a state of changing their beliefs or behaviors in a consistent habituated way by the end of the first year. The "lead" teachers made more gains in moving toward the "ideal" in their perceptions about instruction. In addition, the students of the "coached" teachers reported greater movement towards the "ideal" in the classroom.

Two of the "uncoached" teachers had changed a few surface characteristics but were in fact still in Lewin's UNFREEZING phase. The third uncoached teacher, more conceptually focused at the start of the study, made some changes in her thinking and actions but still chose which classes received the MGMP units (enriched sixth grade) and which were given a more traditional, textbook focused treatment (pre-algebra).

Although most of the "lead" and "coached" teachers had moved into Lewin's CHANGE phase by the end of the first year they remained inconsistent in their classroom practices. While one lesson would be very good, the one which followed might show a return to a previous instructional mode, for example, a return to questioning such as "Tell me what you do to find the area of a rectangle (requiring a computational rather than a conceptual response)." If there was a surprise in the data from this first year it was in the length of time we found teachers needed support in order to make substantial changes in their instruction. Lasting changes must become habituated and one year was simply not enough time for this internalization to be completed.

The Teaching Style Inventory for the second year confirmed our earlier hunches. The lead teachers as a group ended much closer to the ideal than the other two groups, with the coached group second and the uncoached group last. It is also interesting that the lead group continued to make change over the second year while among the other groups only one teacher in each made substantial change in year two on the Teacher Inventory (Table 6). The picture from the Student Inventory (Table 7) is consistent with the result from the Teaching Style Inventory. The students of each of the four lead teachers perceived substantial change toward the ideal over the second year. In the coached and uncoached group the same teacher who continued to show change on the Teaching Style Inventory was perceived by their students as changing toward the ideal. The other students of the other five teachers rated the teachers in a way that actually moved slightly away from the ideal.

The second year proved to be a year of substantial and significant change. The "lead" and "coached" teachers demonstrated some real breakthroughs in their understanding of what it means for children to learn. One of the teachers said near the end of this second year, "I find that I am having trouble remembering what I was like as a teacher before MGMP. It seems like I have always believed that you should teach this way."

Table 6 - Teacning Style Inventory

Teacher Code	SP '85	SP '86	SP '87	Change
A-1	53	36	30	-23
A-2	61	36	29	-32
A-3	62	53	44	-18
A-4	53	22	16	-37
B-1	65	51	40	-25
B-2	48	32	37	-11
B-3	51	43	42	-9
B-4	54	44	42	-12
C-1	67	53	49	-18
C-2	55	38	37	-18
C-3	80	71	51	-29
X	59	43.5	37.9	
SD	(9.2)	(13.3)	(10.0)	

Sp '85 TO Sp '86 Differences Significant at $P < .001$

Sp '86 TO Sp '87 Differences Significant at $P < .02$

Sp '85 TO Sp '87 Differences Significant at $P < .001$

Table 7 - Student Survey of the Classroom

Teacher Code	SP '85	SP '86	SP '87	Change
A-1	28.78	27.37	25.79	-2.99
A-2	30.23	27.63	24.90	-5.33
A-3	26.82	25.54	23.33	-3.49
A-4	26.40	26.42	18.48	-7.92
B-1	27.68	23.07	20.22	-7.46
B-2	27.02	23.42	24.11	-2.91
B-3	26.98	21.44	23.80	-3.18
B-4	27.98	24.30	25.28	-2.70
C-1	26.11	22.14	22.89	-3.22
C-2	24.07	22.48	25.93	+1.86
C-3	27.83	26.75	20.48	-7.35
X	27.26	24.60	23.20	
SD	(1.92)	(2.19)	(2.48)	

Sp '85 TO Sp '86 Differences Significant at $P < .10$

Sp '86 TO Sp '87 Differences are not Significant

Sp '85 TO Sp '87 Differences Significant at $P < .10$

This was said by a teacher who, at the beginning of the first year, could be characterized by her response to a student's question of, "Oh, you don't understand how to add decimals? Well, you first line up the decimal points and then ... ."

Outreach Teachers

Of the teachers who entered the project the second year, complete data was collected on 6 of the teachers. This data cannot be strictly interpreted as peer coached or uncoached because each outreach teacher was in a building with an experienced teacher and all sorts of interactions took place. In addition, these teachers were entering a more established network of experienced teachers and more group interaction over the year (Tables 8 and 9). The most we can say is that four of the six made substantial change toward the ideal over the year. The change was consistent with that observed among the non-lead teachers over the first year of the whole project. This is a very promising result as it suggests that interaction with experienced teachers can be a powerful intervention. This may be a way to extend the ultimate pay off for the labor intensity of coaching an initial group of teachers.

Table 8 - Outreach Teachers
Teaching Style Inventory

Teacher Code	SP '86	SP '87	Change
D-1	56	55	-1
D-2	45	42	-3
D-3	46	36	-10
D-4	67	45	-22
D-5	52	42	-10
D-6	70	58	-12
Mean	56.0	46.3	
S.D.	(10.53)	(8.67)	

Table 9 - Outreach Teachers
Student Survey of the Classroom

Teacher Code	SP '86	SP '87	Change
D-1	28.35	27.26	-1.09
D-2	26.75	27.61	+ 0.86
D-3	27.15	23.38	-3.77
D-4	24.72	18.00	-6.72
D-5	22.09	19.32	-2.77
D-6	27.39	21.98	-5.41
Mean	26.08	22.93	
S.D.	(2.29)	(3.94)	

Interviews

The original group of teachers were interviewed after the first cycle of MGMP Unit and transfer task. For most of the teachers these first interviews were in January or early February. At the end of the year these interviews were repeated with the content focus questions changed from Probability to Similarity. In the second year all 20 teachers were interviewed at the end of the year with content questions covering both units. Hence, for the two year teachers we have three interviews; for the outreach teachers we have one interview.

The interview questions (see Appendix A) ranged from general questions on seventh (or sixth or eighth) grade curriculum, students, and teaching strategies to more specific questions on MGMP philosophy, the instructional model, the units, the transfer tasks, and feelings about the project. The interviews served as another data source to triangulate with observations, and paper and pencil inventories.

The interviews turned out to be extremely useful both as a research data source and as an aide to the coaches. Information from the interviews helped shape the second summer workshop. The teachers were very introspective about their own progress. They often identified areas in which they needed improvement

that were consistent with the coaches insights from being in the classes. Often the teachers realized that they were "telling" students everything and leaving little for the students to clarify or discover for themselves. They were also sensitive to pacing problems and to their problems with what was needed of them during exploration. On the other hand, the early interviews confirmed the evidence from teachers and student inventories and observations that the teachers were able to talk about ideas fitting MGMP philosophy before they were able to consistently act on these ideas in their classrooms. Thoughts changed before actions. Finally, for some of the teachers (primarily the coached and lead teachers), their thoughts became beliefs and their actions became habituated behaviors.

The Summer Workshops and Networking

The overall reaction of the teachers to the summer workships was extremely positive. For most of the teachers this was a rare opportunity to interact with their peers. Even though networking was not a significant initial component of the study, the teachers' expressed needs and desires led us to build on the summer experience with pull back sessions and social occasions to cement the networking.

The cornerstone of the summer workshop was the modeling component. Each summer, middle school students were recruited to form heterogeneous classes of approximately 30 students. The workshop was held in a local middle school. The students attended two hours each morning from 8:30-10:30. This allowed two 55 minute class periods with a ten minute break. The staff taught the probability and the similarity units with the teachers observing. After the students left, the staff and teachers critiqued the lessons and discussed any spin off concerns that were raised. These sessions lasted one to two hours depending on the lessons and the sorts of questions raised by the teachers or staff.

Many things happened as a result of this opportunity to observe another person teaching and to discuss the lessons with peers and staff. The staff grew enormously in credibility with the teachers. Our being willing to put ourselves on the line and being very open to criticism and suggestions broke down the ivory tower notions that teachers often have about university faculty. In fact, at the end of the workshops the teachers expressed amazement at how hard they had come down on us during the critiques. It was a confidence builder for them that while they saw that we were good teachers who could offer them a lot, we were not "Superteacher". Students still got off task and we had to cope. This made them feel that they had the confidence to try teaching the units. They knew that we did not expect things to work perfectly all the

time. In addition, they experienced discussing a lesson and observing ideas and suggestions played out in class the next day. This was good preparation for being coached.

Modeling the units made opportunities for the staff to probe the subtleties of the mathematics content. Even though we had conducted a one day overview of the content and activities, this was by no means sufficient to help teacher understand the content in enough depth to teach it. Probability was completely new to nearly all of them. Their books had sections on probability which took a formula approach. Many of the teachers admitted finding reasons to skip the section or admitted teaching it mechanically with little understanding themselves. This was also true of parts of the Similarity unit even though overall this was more familiar content. In spite of observing the units being taught, depth of content knowledge remained a problem which was sorted out during coaching (for the coached teachers!)

Our ultimate goal was not just to implement MGMP Units in the classrooms of the teachers, but also to have the teachers come to understand the instructional model in sufficient depth that they are able to use the model and the ways of thinking about instruction that support the model in new circumstances. The first summer workshop brought the teacher to the stage of awareness relative to the model. We had an intensive seminar on the instructional model at the end of the first week of observation. This was followed by two small group sessions devoted to attempting to construct an MGMP type lesson. During the observations the teachers given specific directions about how to focus their attention. The first summer the teachers were asked to observe different aspects of the instructional model -- first launching, then exploring, and finally summarizing. In spite of this concentrated attention, the teachers did not move beyond awareness the first summer. The first transfer tasks attempted in the fall were pale imitations of MGMP. The teachers did not understand the role of questions and the nature of a mathematical task designed to help students engage in purposeful exploration. Many of the transfer units consisted of activities strung together to foster activity with little underlying mathematical purpose. The uncoached teachers for the most part stayed at this stage throughout the first year. The coached and lead teachers realized that their transfer tasks had not captured the MGMP model, but unlike uncoached teachers, they had help available to think through what had happened with the first transfer task. This help provided a basis for a much better effort on the second transfer task.

As we ended the first year and entered the second summer workshop, we characterized the lead and

coached teachers as having moved through the unfreezing (awareness) stage and entering the change stage. The three uncoached teachers were in the awareness stage with their focus being on teaching the MGMP Units well, but with little insight or desire beyond that. In preparation for the summer, and the addition into the group of the outreach teachers, we had a 1 1/2 day pull back session in May. At this session we planned an intervention designed to help teachers confront their limited view of the curriculum. At this point the teachers all saw MGMP units as add-ons to an already jam packed curriculum.

We began by photocopying pages on fractions from the 5th, 6th, 7th, and 8th grade texts in a popular textbook series. We removed all grade level identifying marks and gave a set to each of the teachers. Working in pairs they were to figure out what order by grades the pages represented. This was a surprising difficult task. Imagine the teachers amazement when they found that the pages they thought were the simplest conceptually were from the 8th grade. This provided an excellent lead in to the main activity. We worked with the group to generate a list of topics, concepts, skills or ideas that comprise the seventh grade curriculum. They, of course, generated a list several pages long. Then we classified the list into ideas that had been taught in earlier grades and ideas that were new to grade seven. There was an almost stunned silence when the group completed the list and had identified at most a half dozen <u>new</u> ideas for grade seven. We then made a second pass through the list to identify relationships among the ideas on the list. What clusters or chunks of related ideas could we partition the set into? Looking for relationships and connections was a new experience for the teachers. This caused a reevaluation of the MGMP units and a growing appreciation for the structure of the underlying ideas and the mathematical tasks designed to foster students understanding of these ideas. The teachers were now eager to enter the second summer workshop. Many of them indicated that they had questions that they wanted to get sorted out by observing us teach again.

Another deep seated problem that the summer experience was designed to challenge was low teacher expectations of students. There are two aspects of this low expectation. The first is the normal response to new content -- "Students can't do this because they can't do ... ." This often means "Students can't do this because it is hard for me!" The second aspect of low expectation which we observed was that teachers label or give up on students very quickly. In order to create a situation where we could challenge these beliefs, we made a different kind of observing assignment the second summer. We asked each teacher to pick a

student to observe. We wanted the teacher to be able to describe what life was like for his/her student in each class. What did the student understand/not understand? What was hard/easy? Was the student on/off task? Did the student find the tasks interesting/boring? We asked them to try to get to know what was in their student's head. How did their student perceive mathematics? For teachers who are used to dealing with 5 or 6 classes of 24-35 students per day, observing one student closely was a luxury. We did, however, have a hard time getting teachers to focus on cognition and not behavior. Over and over again a teacher would declare in the discussions after class that his/her student was hopeless--would never understand--only to have student do something very clever or insightful in the next class or so. This caused considerable rethinking about students and their capabilities.

Another change from the first summer was that we had the teachers all observe the same classes. The first summer we split the teachers into rotating groups so that they could see four staff members teach. The second summer they saw only two staff members. However, the discussion were smoother because all of the teachers observed the same phenomena. The advantages of this outweighed the greater variety of experiences. However, the observation assignments each had advantages and were appropriate for the teachers at their stage of development -- focusing on the instructional model and content the first summer and then focusing on student learning the second.

The second summer we asked the group to decide on a topic that they wanted to use as a transfer task. We divided the group into smaller groups of 3 or 4 teachers. Each group had teachers from the first year of the project and teachers who joined the second summer. The teachers as a group chose functions as the topic. Each day we had a working session on teaching fractions. At first the group intended to design a two week unit to teach meaning of fractions, equivalence and all four operations! After a few days they decided that they needed at least two weeks to teach meaning and equivalence alone. This was a big breakthrough for many of the teachers. They were, for the first time, examining fractions and appreciating the difficulties students have. One outreach teacher had been an engineer before becoming a middle school teacher. He came in one morning early in the second week and declared that he wasn't sleeping at night because of fractions. He said that he had begun to realize that he didn't know anything except routines for doing things.

At the end of the workshop each teacher got a copy of each group's work. Each person then

constructed their own transfer task from the total group effort. One interesting off shoot of this activity is that three of the four lead teachers have continued to meet on a regular basis for over a year working on a polished unit for teaching fractions. They have given several workshops on teaching fractions that have been very well received by elementary middle school and high school teachers.

During the second year we had a pull back session during each semester and at the end of the project. As we said earlier, these were not a part of our original plans for the intervention. However, the teachers wanted to get together to interact with each other. Two of the uncoached teachers from the first year really pushed for these. They had felt very much "behind" the coached teachers in their thinking the second summer. These pull back sessions also helped the outreach teachers. Having outreach teachers and experienced teachers together was very successful. The experienced teachers just swooped the new ones up and made them a part of MGMP in a hurry. The experienced teachers have come with credibility. The new teachers went to the experienced teachers to get their questions answered.

In the pull back sessions we took the opportunity to continue to model good MGMP type lessons with new content. Each time a staff member or teacher taught a lesson to the whole group and we had a mini-critique of the lesson. In addition, we asked the teachers to talk about their transfer tasks and teaching the units. This lead to more general discussions of content, teaching and student learning.

Throughout the summers workshops and at the pull back sessions we distributed copies of papers and articles for the teachers to read that related in some way to the problems we discussed. Mark Driscoll's "Research Within Reach" and David Johnson's "Making Every Minute Count" were among the things given to each teacher. Other papers focused on group learning, questioning, and curriculum and teaching issues. We did not discuss every reading in detail, but some of the teachers found the readings very helpful.

To recapitulate, the components of the Summer Workshops and the goals for each component are given in outline form:

Component	Goals
Modeling and Discussions	
Staff teaching students. Teachers observing.	Building confidence in content knowledge. Raising pedagogical and management

	questions related to the underlying MGMP instructional Model.
	Guiding teachers in learning to observe classroom and students in particular ways.
	Expanding teacher expectation of students.
	Establishing staff credibility.
Curriculum Work on Transfer Tasks	Unpacking the MGMP instructional model.
	Raising curriculum questions concerning importance of ideas and relationships.
	Focusing on transfer of model to new situations.
Readings	Promoting professionalism
	Supporting MGMP philosophy as having a research base.
	Raising teachers' ability to critique ideas.
Networking	Building a continuing support group for change.
	Breaking down the barriers of isolation felt by many teachers.
	Promoting professionalism.

The Coaching Component

The major question the MGMP staff set out to explore was "How much and what kind of help do teachers need to implement effectively an MGMP unit in their classrooms and further, to transfer use of the instructional model to other aspects of their curriculum?" A major component of the types of help investigated was classroom consultation or coaching. Over the two years of the project 8 teachers were coached by 4 staff members. These 8 teachers were subgrouped into two groups: 4 who were the only MGMP teacher in their building and who made a commitment to peer coach another teacher in their building, and 4 consisting of two pairs per school who were coached with no further commitment to coach another teacher. These two groups are referred to as the lead teacher group and the coached group. We will first discuss global aspects of coaching and its effects and then make some comments about the additional effect of "expectation" on the lead teacher group.

The diagram in Figure 4 shows how the staff conceptualized coaching. A simplified scheme of the act of teaching shows the circle of planning, instructing, student learning, and reflecting leading to more planning, etc. The staff recognized the importance of impacting teacher beliefs and knowledge about content, strategies for teaching, and how students learn. Implicitly or explicitly these teacher beliefs drive the types of decisions teachers make in choosing the curriculum, setting goals for student learning, and carrying out instructing in the classroom. Even the types of evaluation used are influenced by teacher beliefs. If coaching is to be effective, it must interact with both the circle of teaching and with teacher beliefs. This is indicated by the coaching arrows which intersect the teaching phases, but aim at impacting both teacher beliefs and practice.

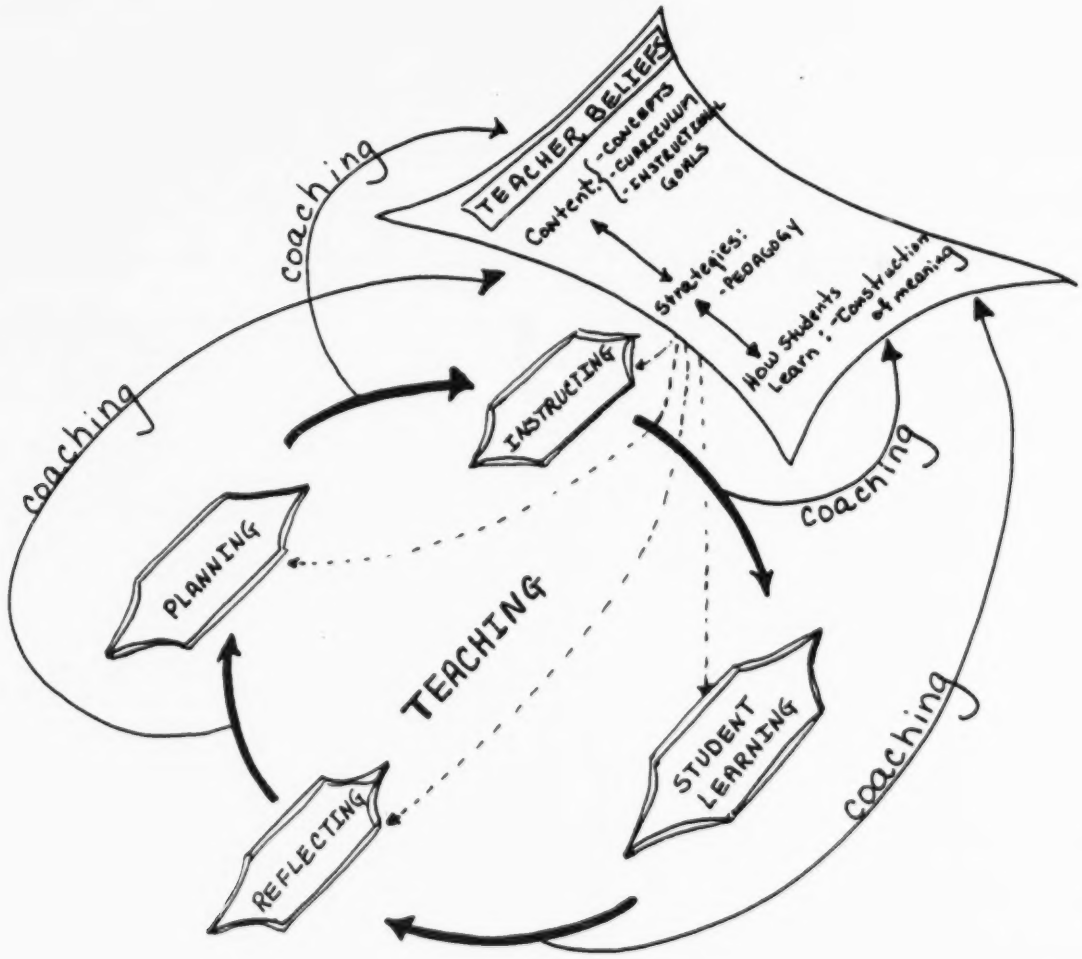


Figure 4. Staff's concept of coaching

As we set out to develop ways of establishing coaching relationships, we did so with the recognition that each pair needed to become two professionals working together to improve the mathematics education of children. The teachers involved were professionals. They were by most existing criterion successful teachers. We had to establish a working relationship that showed our respect for them and our willingness to let them decide in what ways we could be most helpful. Each coach-teacher pair went through different negotiations to establish a working relationship. The personality of each had to be accommodated. In other words, there is not algorithm for establishing an effective coaching relationship. It is a sensitive negotiation between two professionals, each with different expertise, who are committed to working together. Observing the same phenomena (classroom instruction) and discussing their different perception of the classroom and student learning can lead to improved perception on both parts.

The general goals of the staff were to help teachers improve four aspects of classroom practice and instruction:

* Communication patterns
* Teaching
* Planning for Instruction
* Instructional Thoughts and Actions

These were judged to be critical to implementation of the MGMP instructional model.

As we worked to establish comfortable coaching relationships with our teachers, we found ourselves called upon to play many different roles. One of the first roles we played was that of content expert. The teachers were teaching MGMP units which contained new content for them. They quickly became quite comfortable in asking us for specific help in understanding the subtle points of the mathematics they were teaching. We got a glimpse of the awful isolation teachers feel when they have no support network with which to talk over problems. Here is an excerpt from a coaching record that makes this point. (11/14/85)

> "I had a lot of questions on the review sheet for probability. The questions on three dice odds and evens, on four T-F questions and on 6 child families gave her great trouble. Multiplying probabilities was the source of the confusion. She said, 'When I finish my minor will I know more about this?' (She had decided to pursue a secondary math minor after the project started.)
> I went over my comments on the lesson with her. Then she said, 'I am really pleased with this unit and what my students have gotten out of it. It has made such a difference to have you here with me. I knew when I taught the Factors

> and Multiples Unit that the ideas were good for the students, but I got so frustrated when I didn't understand or things didn't go well. This time I knew I could call you if I didn't understand the math. It makes such a difference. You were warm and supportive and it gave me confidence that I could do it. I really appreciate your help and I am so pleased with how it went.' "

This quote leads us to another role we played during coaching--that of providing the emotional support our teachers needed to try something different, to change their instructional practices. Change is scary. Students are resistant to change. Coaching can provide the shared responsibility and support needed to persevere until the change in practice becomes comfortable and effective.

As stated earlier in this report we used Shulman's Model of Pedagogical Reasoning and Action (1987) as a theoretical frame to guide our efforts to help teachers. The reflection stage was a primary focus for our coaching. We found ourselves playing the role of a teacher reflecting on student learning and instruction in order to better plan upcoming lessons. Many of the coached teachers reported that even after the coaching intervention was terminated, they continued to use "pretend" conversations with their coach to help reflect on what happened in their classes. Modeling the questions one can ask oneself to help make better use of the data from the class was a powerful help to improving the coached teachers ability to reflect on today's lesson in planning tomorrows, etc. Planning for tomorrow changed from "turn the page to see what is coming up" to "what do the students understand from today? What naive conceptions do they have? What questions worked well today? How can I structure the mathematical tasks for tomorrow to help students see ...? How can I relate today's lesson to tomorrow's? How does tomorrow's relate to other things we've studied?

We found ourselves called upon to play the role of providing instructional feedback to the teacher. We became a pair of eyes that could focus on students1 mathematical insights and problems that are not always obvious from the front of the room. This role allowed us to focus on learners and learning. We found that sharing vignettes of student interaction was a very effective way to help our teachers rethink the expectations they set for students. Here is an excerpt from a coaching report that shows such an interaction.

> "We talked about the earlier class where things had been chaotic. T said she hadn't done a good launch and had had to bring students back together twice to clear things up. Her afternoon directions were excellent.
>
> She is torn over the time homework takes, but feels that it is important for students to get their confusions sorted out. She wants reassurance that the

homework assignments aren't too hard. We talked about the differences between MGMP assignments and book assignments. Each MGMP question is different and requires thought. Book problems come in huge chunks of sameness. She said that last year when she did no story problems, her students had a lot of difficulty with the Factors and Multiples homework. She feels that this year her students can handle more complicated problems.

We discussed her modeling of correct language and symbolism. I pointed out an example where T pressed a student to rethink her answer of 11 as a probability statement. The student finally realized what she was saying incorrectly and gave 11/36 which was what was needed. T has been very careful about this.

I suggested that she let the students know that she expected them to <u>try</u> every problem and that she knew they were very capable of figuring out what was being asked. She felt much more like sticking with her high expectations when I reminded her that Ervin had recognized and pointed out the pattern of zeros in the chart for last night's homework that made producing the table very simple.

Toss two dice: subtract the smaller number from the larger.

Dice	1	2	3	4	5	6
1	0	1	2	3	4	5
2	1	0	1	2	3	4
3	2	1	0	1	2	3
4	3	2	1	0	1	2
5	4	3	2	1	0	1
6	5	4	3	2	1	0

Ervin is a learning disabled student. She just needed to be reassured that seventh graders <u>can</u> be required to think."

Another role we played was that of <u>modeling professionalism</u>. The teachers saw the value of an open questioning attitude about teaching. They experienced the value of two professionals critiquing a lesson together. They became braver and more insistent on feedback. There were many instances of teachers talking and collaborating on aspects of teaching mathematics. They reported as being different from before the project coaching. Six of the eight coached teachers became very involved in professional activities outside their own schools. We helped the coached teachers interact with their own schools (administrators and other teachers) and with the larger mathematics education community. Two of the coached teachers were nominated in the second year of the project for Presidential Awards from the State Of Michigan. These nominations came from and were supported by their colleagues and administrators.

The parts of an MGMP lesson require that the teacher assume different roles in the classroom. Most of our teachers were used to only one role - that of given information. In order to help teachers understand

what their role was during student exploration, we often made opportunities to model questioning, redirecting, extending, and challenging students as they worked in groups on an exploration. This role of demonstration teacher was very effective at helping our teachers change their beliefs about what students can think about in mathematics. Our reports on student conjectures gave the teachers help in asking good summary questions. During the project they changed their summaries from one in which they told the students what they should have found to summaries where the role of the teacher was to ask questions, to challenge answers, and help students formulate the mathematical conclusions. Another aspect of helping teachers see the value of exploration and summary, was the role of the coach in creating good examples of questions that can reveal student thinking and reasoning. We played the role of experts on figuring out connections and relationships among and between mathematical ideas and situations. Over the two years the coached teachers became much more aware of the value of helping students see connections.

The following excerpt from coaching and observation notes show the coach affecting both the explore and the summary phases of the LES.

> One of the exemplary units of instruction was on Similarity. In the explore part of Activity 3, the students were given a page containing rectangles. They were to use a transparent grid to determine the lengths of the sides and to determine the area and then decide which rectangles were similar using ratios of corresponding sides. The areas were collected so that the growth of the areas in similar rectangles could be discussed in the summary. The teachers were told in the scrip that the students probably did not know the connection between the formula for area and counting the unit squares contained in a rectangle. It was also suggested that this connection not be made until the summary but to observe what strategies were being used by the students in the explore part of the activity.

The following are two incidences from two different classrooms concerning the above activity:

> Classroom 1.
>
> The coach was moving about during the explore observing groups of students and occasionally challenging or extending student results; the coach was modeling the appropiate teacher behavior and was going to share her observations with the classroom teacher so that the classroom teacher would have an idea of what her role was during the explore and how to use the observations in the summary. The following is a quote from the coach's report on the activity:
>
> "I was delighted to watch one student try to count an area with a large number of squares - he kept losing his count. Out of frustation he finally counted the bottom row and the he paused - looked at the rectangle and said to himself "there are 12 of these rows so that area must be 12 times ? Oh this is the formula for area!" As he says this last statement he looks at me and beams with his discovery."

Classroom 2:

The teacher was going to summarize Activity 3. She put up a rectangle with the measurement of 3 and 4 written next to the length and width of the rectangle. She wanted to see if students were making the relationship between the formula for area and counting the unit squares. One of the communication patterns in questioning that was coached for was to stay with a student's response long enough to assess the student's understandings. The following conversation between the teacher and a student in the class is from the field notes of the observer in the class:

T: OK, what is the area of this rectangle?
S: 12 square units.

T: How did you get that ?
S: I multiplied 4 by 3.

T: Why did you do that?
S: You multiply to get area?

T: But why does that work?
S: (Shrugs)

T: Why 3? Why 4? And why multiply instead of adding or something else?
S: You multiply the short side by the long side.

T: Wait, let's back up. What is area?
S: It's the number of square units in something.

T: How could you find out how many squares there are?
S: I could count them.

T: What else could you do?
S. I could multiply.

T: What by what?
S: The length by the width.

T: Now what do the 4 and the 3 have to do with it?
S: OHHHH! There's 4 rows and the 3 in each row.

T: Ok, what did you do to find the area of a rectangle?
S: Multiplied 3 by 4 to find out how many there are altogether.

For the teachers we coached we were a source of curriculum ideas. We helped them to consider ways in which MGMP could be integrated into the curriculum. At the beginning of the project the teachers all viewed the MGMP units as "add ons". They worried about taking time away from the textbooks to do these extra's. The teachers who were coached made much greater progress in rethinking the curriculum of seventh grade. They became committed to looking for big ideas around which to organize the year. They began to see the MGMP units and their transfer units as integral parts of the curriculum. They were willing

to deemphasize computational aspects of 7th grade curriculum in favor of spending more time on probability, geometry and the development of an understanding of fractions, equivalent fractions, and percents. The uncoached teachers tended to continue to view MGMP units as extras to be done only if time allowed. The coached teachers saw ways to relate many other ideas to the MGMP units. For example, in the second year one coached teacher who was observed teaching activity 7 of the probability unit managed to have students practice estimating, rounding, and simplifying fractions, changing decimals to fractions and vice versa all while doing a probability activity.

Finally, as coaches we found ourselves playing the role of philosopher. Our efforts to help our teachers change their instructional beliefs and practices were really aimed at helping teachers to examine their philosophy of mathematics education - to examine their expectations and beliefs about how children learn and about what mathematical goals we should set if we want to maximize student growth. At one of the pull back sessions some of the uncoached teachers admitted that they felt that the "other teachers" (coached) were way ahead of them. They seemed to be amazed at how the coached teachers could talk about what they believed and what they had tried in their classrooms.

Not all of the teachers in the study changed in the same way: The uncoached teachers made fewer changes. However, in all the teachers we saw the following kinds of changes in the four basic areas.

I. COMMUNICATION PATTERNS:

Questioning ---Pushing students thinking by asking open-ended questions
---Asking for justification or strategies
---Focusing on how students are thinking
---Reducing questions that are used solely to keep students on task and paying attention
---Asking conceptual versus algorithmic/computational ones

Responding ---Asking for students responses in whole sentences
---Requiring students to express complete thoughts
---Listening and valuing what students have to say (used to inform the teacher)
---Asking for justifications

II. TEACHING: (Transfer Tasks or lessons Different from the MGMP Units)

---Using non-examples
---Using concrete manipulatives beyond those used in the MGMP units
---Using richer teacher talk during direct instruction
---Adapting to conceptual breakdowns of students
---Helping students find a way to figure out or make sense or problems

---Making linkages (helping students see/become aware of these)
---Using problem solving activities
---Creating a fuller class period (less down time)
including agendas, homework, call-outs

III. PLANNING FOR INSTRUCTION:

---Developing lessons that are well-crafted--including questions
---Reporting more time on planning
---Emphasizing understanding the content--maintaining a conceptual focus
---Alloting more time to conceptual development

---Planning linkages in the way they think about and structure their curriculum (reflection)
---Being flexible in planning for instruction (using groupings, pairs, individual exercises)
---Allowing for activities with a challenge and problem solving focus

IV. INSTRUCTIONAL THOUGHTS AND ACTIONS:

---Considering what it means to know
---Taking responsibility for students learning
---Understanding has a wider interpretation
---Being more reflective about curriculum, mathematics, students, teaching, etc.
---Valuing exploration and pushing for generalizations
---Exhibiting a greater consciousness about LES model
---Valuing mathematics, providing a motivation for students to learn math (beyond grades.)
---Seeing or thinking about the MGMP units as mainstream, not as add-ons
---Taking time to teach
---Taking responsibility for curriculum decisions
(not leaving these up to a text or other dictatorial source)
---Taking responsibility for assessment

Expectation

Over the first year of the project the coached and lead teachers participated in the same intervention. The two groups had the same summer workshop and the same amount and kind of coaching Yet, there were differences in how the two groups responded. Labeling one group lead teachers even though the label was used only privately with the four teachers when they were recruited seemed to make a difference. They entered the project knowing that they were expected to take a leadership role in their schools by coaching another teacher. This different expectation held the four lead teachers accountable in a way that coaching alone did not reach. The four lead teachers bought into the project intellectually over the first year as

evidenced by their Teacher Inventories and by their interviews. However, they were slower to exhibit change in their actions in the classroom. The students perceived little change the first year, but substantial change the second year. These four lead teachers have developed a confidence and professionalism over the life of the project that have allowed them to not only make an impact in their school districts, but to also become a part of the leadership of the state Teachers of Mathematics organization.

A summary of the Strategies for coaching that were a part of the MGMP intervention are given in outline form.

Changing teacher beliefs.

Coaches

provide rationale for needed change.

help develop an instructional philosophy.

model appropriate teaching strategies with an exemplary unit of instruction.

model professionalism by encouraging discussion of all aspects of teaching including critiques and suggestions.

focus discussions on teacher strategies, objectives, teaching activities, communication and student learnings.

provide opportunities for curriculum development.

Changing teacher's actions.

Coaches

provide the emotional support for change.

provide instructional feedback on
- student learning
- communication/questioning
- learning activities

help teachers establish
- relationships among important mathematical ideas
  and
- a conceptual focus in their teaching

Connecting teacher actions and beliefs

Coaches and Teachers Work Together To

plan and implement effective units of instruction

identify the important concepts in mathematics and plan the curriculum around these ideas.

explore means of evaluating students' understanding.

Expanding Teacher's Roles.

Teachers

assume a coaching role with their peers.

assume a leadership role in their districts.

conduct workshops and inservices, give speeches, and serve as consultants for mathematics education.

become professionals.

CONCLUSIONS AND IMPLICATIONS

The major questions guiding this study were:

How much and what kinds of assistance do teachers need or think they need to teach successfully an MGMP Unit and further, to transfer the instructional model imbedded in the units to other appropriate parts of the curriculum?

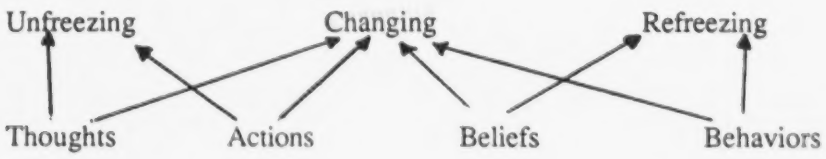
How effective is coaching as a strategy in changing teachers' instructional emphasis from a computational to a conceptual orientation as reflected in the exemplary mathematical materials (MGMP Units)?

The data gathered consisted of Student Inventory results, Teacher Inventory results, Teacher Interviews, classroom observations, and coaching reports. These data were analyzed and reported in two ways in this document. The quantitative data was analyzed by groups (lead, coached, uncoached) and over all teachers. Case studies were written on one teacher from each group. (See Appendices B-D)

Analysis of the data gathered supports the following conclusions.

1. The Summer Workshops and Networking provided sufficient assistance to all the teachers to teach an MGMP Unit with some success. This was not sufficient help to promote transfer to other parts of the curriculum. All the teachers were able to teach the Probability and Similarity Units, but none of the

uncoached teachers were able to incorporate the MGMP instructional model and the MGMP philosophy into their repertoire. If we look at Lewin's model of change (and our interpretation)



We would characterize the uncoached teachers as finishing the project on the end of the continuum Unfreezing to Changing. They were able to think and act in the specific ways required by the script of the units, but had not gone beyond this. This was also true of the outreach teachers. They were very successful at teaching the units. However, the teachers who were coached by one of the first year teachers moved further into beginning to change their beliefs about students and the relative importance of computation and conceptual development. Teachers acting alone did not continue to think about and question their instructional goals and strategies in the classroom.

2. The data provides considerable evidence that coaching is an effective strategy to help teachers make fundamental changes in their instructional practices. One major result of coaching was that it provided the teachers with a vocabulary for communicating ideas and a frame for thinking about and reflecting on their instruction. In the Levels of Impact Model of Joyce and Showers, the lead and coached teachers all attained the Principles and Skills Level. They could think effectively about problems of instruction and had the skills to act. At least six of the eight lead and coached teachers reached the Applications/Problem Solving Level. They use the MGMP instructional model and philosophy and integrate it with their own style and other strategies in their repertoire. In Lewin's model of change these teachers have reached the refreezing stage where their beliefs and behaviors are becoming habits rather than actions requiring deliberate thought.

The lead and coached teachers demonstrated some real breakthroughs in their understanding of what it means for children to learn. They are asking better questions and reflecting on student responses to evaluate understanding as one lead teacher expressed it, "These wonderful questions that cause my students to discuss and argue about answers are coming out of my mouth and I don't even know where they are coming from." Another payoff for the labor intensity of coaching is that this group of teachers have reached

a level of professionalism that has moved their sphere of influence beyond their own classroom, into their districts and beyond their districts into leadership roles within mathematics education in the state.

The major implication of this study is that changing teachers beliefs and practices requires a substantial long-term staff development program. We believe that an intervention that provides less than two years of intellectual and emotional support for teachers is unlikely to have any lasting effect. Even if the staff development goals are to implement specific curriculum ideas, teachers need support through at least two rounds of teaching these ideas.

In addition, the study provides specific help for those who are planning staff development programs. The various components of the intervention are described in this document in detail. Evidence of the ways each component can contribute to a staff development program are given. Major aspects of the intervention are providing exemplary units in which the instructional model is embedded, modeling the teaching of these units to students, and coaching teachers during implementation. The project provides some beginning evidence of the effectiveness of peer coaching. This aspect of the project needs further investigation. The project, also, cannot definitively answer the question "What is a minimal level of coaching likely to cause desired change?" Our sense is that when coaching occurs it should be on an intensive daily basis for a period of time as opposed to one a week or less often spread uniformly. These details of intensity and spread of coaching need further investigation.

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Appendix A

Appendix A-1

CONFIDENCE SCALES

Indicate, by writing the appropriate number and letter in the boxes beside each question, to what extent you feel confident that you could <u>solve</u> the problem and to what extent you feel confident you could <u>teach</u> middle school students to solve such a problem.

Solving	Teaching
1. I am confident I can solve this problem.	A. I am confident I can teach this problem.
2. _____	B. _____
3. _____	C. _____
4. _____	D. _____
5. I am confident I cannot solve this problem.	E. I am confident I cannot teach this problem.

Question	Solving	Teaching
1.	☐	☐
2.	☐	☐
3.	☐	☐
4.	☐	☐
5.	☐	☐
6.	☐	☐
7.	☐	☐

Question	Solving	Teaching
8.	☐	☐
9.	☐	☐
10.	☐	☐
11.	☐	☐
12.	☐	☐
13.	☐	☐
14.	☐	☐
15.	☐	☐
16.	☐	☐
17.	☐	☐
18.	☐	☐
19.	☐	☐
20.	☐	☐

TWENTY MATHEMATICS PROBLEMS

1. A bowl contains 3 red marbles, 5 green marbles, and 4 blue marbles. A blue marble is drawn and not replaced. Then the contents of the bowl are thoroughly mixed. After this, you are asked to draw a marble from the bowl without looking. What is the probability that you will draw a blue marble?

(A) $\frac{3}{12}$ (B) $\frac{3}{11}$ (C) 12 (D) $\frac{4}{11}$ (E) $\frac{1}{3}$

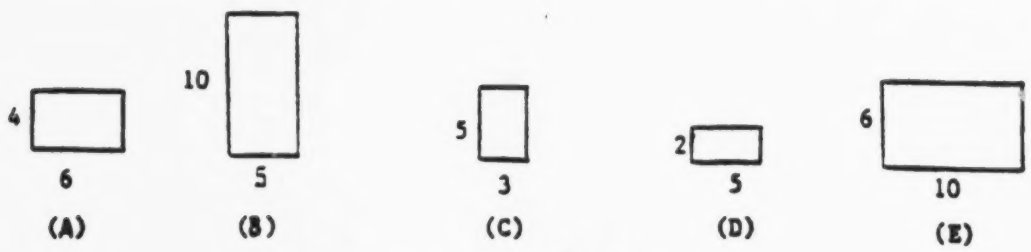
2. A fair coin has been tossed 10 times and has come up heads each time. Which of the following statements is <u>true</u>:

(A) The coin will come up heads on the next toss.
(B) The coin will come up tails on the next toss.
(C) There is an equal chance of coming up heads or tails on the next toss.
(D) The coin is more likely to come up heads on the next toss than tails.
(E) The coin is more likely to come up tails on the next toss than heads.

3. The probability of getting a sum of 12 when two dice are thrown is:

(A) $\frac{1}{2}$ (B) $\frac{1}{3}$ (C) $\frac{1}{6}$ (D) $\frac{1}{12}$ (E) $\frac{1}{36}$

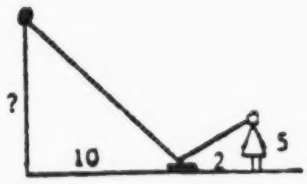
4. Which of the following rectangles is similar to a 10 × 15 rectangle?



5. If two figures are similar, which of the following might be <u>different</u>?

(A) number of sides (B) lengths of corresponding sides
(C) shape (D) size of angles (E) ratio of corresponding sides

6. Joan estimates the height of a flagpole by using a mirror.

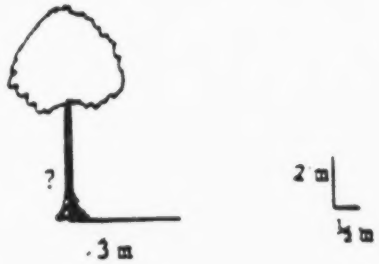


Distances	
To eye level	5 ft.
Joan to mirror	2 ft.
Mirror to pole	10 ft.

How tall is the pole?

(A) 10 ft. (B) 13 ft. (C) 15 ft. (D) 25 ft. (E) 100 ft.

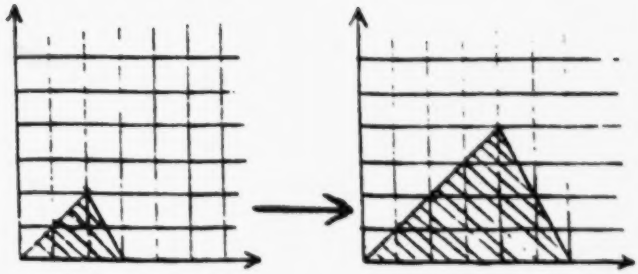
7. A 2 meter stick has a shadow of ½ m at the same time that a nearby tree has a shadow of 3 m.



How tall is the tree?

(A) 6 m (B) 12 m (C) 1½ m (D) 3 m (E) 15 m

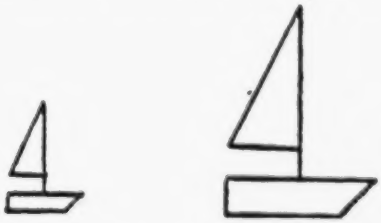
8. Given a triangle and its image.



Which of these transformations was used?

(A) $(x, y) \rightarrow (2x, 2y)$
(B) $(x, y) \rightarrow (x, 2y)$
(C) $(x, y) \rightarrow (2x, y)$
(D) $(x, y) \rightarrow (2x, 4y)$
(E) $(x, y) \rightarrow (4x, 2y)$

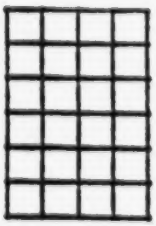
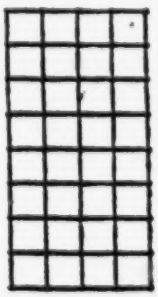
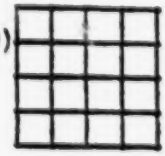
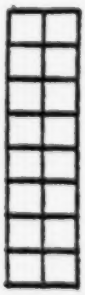
9. What scale factor has been used to enlarge the small sailboat?



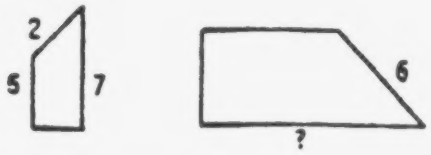
(A) 2 (B) 3 (C) 4 (D) 6 (E) 1/4

10. Given the rectangle

Which of the following rectangles is similar to the given rectangle?

(A)
(B) 
(C) 
(D) 
(E) 

11. The given figures are similar.



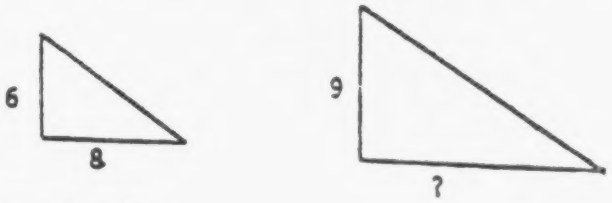
Find the missing length.

(A) 11 (B) 14 (C) 15 (D) 18 (E) 21

12. If the lengths of the sides of a triangle are each multiplied by 3, then the area of the new triangle is?

(A) 3 times larger (B) 6 times larger (C) 9 times larger
(D) 12 times larger (E) 15 times larger

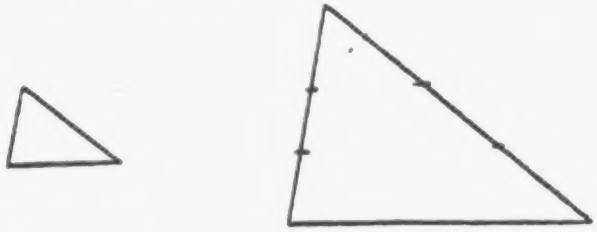
13. These triangles are similar:



Find the missing length.

(A) 10 (B) 11 (C) 12 (D) 13 (E) 14

14. The two triangles below are similar and the lengths of the sides of the larger are 3 times that of the smaller.



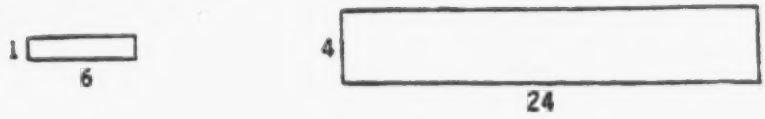
How many of the smaller triangles will exactly fit into the larger one?

(A) 4 (B) 6 (C) 7 (D) 8 (E) 9

15. A man who is 6 feet tall has a shadow which is 8 feet long. At the same time a nearby tree has shadow which is 32 feet long. How tall is the tree?

(A) 30 feet (B) 21 feet (C) 24 feet (D) 42 feet (E) 48 feet

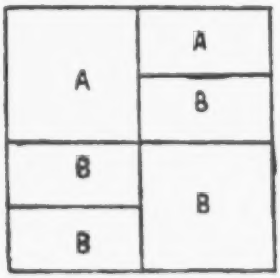
16. Given rectangles of dimensions 1 x 6 and 4 x 24.



The area of the larger rectangle is how many times as big as the area of the smaller rectangle?

(A) 4 times (B) 6 times (C) 8 times (D) 16 times (E) 18 times

17. John is tossing bean bags randomly onto the mat below. What is the probability of a bean bag landing in an area marked B?



(A) $\frac{1}{4}$ (B) $\frac{3}{8}$ (C) $\frac{1}{2}$ (D) $\frac{5}{8}$ (E) $\frac{2}{3}$

18. Sally has a 50% free throw shooting average in basketball. She goes to the line to take two shots. What is the probability that she will make both shots?

(A) $\frac{1}{4}$ (B) $\frac{1}{2}$ (C) $\frac{1}{8}$ (D) $\frac{3}{4}$ (E) 1

19. Two bills are drawn from a bag containing a five dollar bill and 3 one dollar bills. If the experiment is repeated many times, what would you expect the average amount of money drawn per time to be?

(A) $2 (B) $3 (C) $4 (D) $5 (E) $6

20. What is the probability that a family of three children will have 2 girls and 1 boy?

(A) $\frac{1}{8}$ (B) $\frac{1}{3}$ (C) $\frac{2}{3}$ (D) $\frac{1}{2}$ (E) $\frac{3}{8}$

STUDENT INVENTORY

Appendix A-2

Directions

(1) Answer ALL QUESTIONS including the ones ON THE BACK of this page.
(2) For each question, select the answer that BEST TELLS how often the situation occurs in your mathematics class.
(3) SHADE in the circle on your answer sheet that MATCHES your answer choice.
(4) Choose ONLY ONE answer for each question.

	NEVER	SELDOM	HALF THE TIME	USUALLY	ALWAYS
1. Do you find your mathematics class interesting?	(A)	(B)	(C)	(D)	(E)
2. Does your math teacher ask questions that make you curious?	(A)	(B)	(C)	(D)	(E)
3. Does your math teacher encourage the class to find different ways to solve the same problem?	(A)	(B)	(C)	(D)	(E)
4. When your math teacher asks a question, do you have time to think about the answer before you must reply?	(A)	(B)	(C)	(D)	(E)
5. Does your math class spend the whole period practicing computation?	(A)	(B)	(C)	(D)	(E)
6. Do you solve word problems in your math class?	(A)	(B)	(C)	(D)	(E)
7. Does your math class ever work on a problem for an entire period?	(A)	(B)	(C)	(D)	(E)
8. Does your math class ever work more than one class period on a problem?	(A)	(B)	(C)	(D)	(E)
9. Does your math teacher go <u>too fast</u> for you?	(A)	(B)	(C)	(D)	(E)
10. Does your math teacher go <u>too slow</u> for you?	(A)	(B)	(C)	(D)	(E)
11. Do you finish your math classwork early?	(A)	(B)	(C)	(D)	(E)
12. Do you have to hurry to finish your math classwork?	(A)	(B)	(C)	(D)	(E)
13. Are the math lessons <u>too hard</u> for you?	(A)	(B)	(C)	(D)	(E)
14. Are the math lessons <u>too easy</u> for you?	(A)	(B)	(C)	(D)	(E)

****CONTINUED ON BACK****

		NEVER	SELDOM	HALF THE TIME	USUALLY	ALWAYS
15.	When you have trouble with a problem does your teacher show you how to do it?	A	B	C	D	E
16.	When you have trouble with a problem does your teacher tell you the answer?	A	B	C	D	E
17.	When you have trouble with a problem does your teacher give you hints so you can figure it out?	A	B	C	D	E
18.	When you have trouble with a problem are you allowed to ask other students for help?	A	B	C	D	E
19.	Do you work in groups of 2 or more students during your math class?	A	B	C	D	E
20.	In your math class are you supposed to work by yourself?	A	B	C	D	E
21.	Do you use things like blocks, spinners, or rulers in your math class?	A	B	C	D	E
22.	Is the class assignment the same for all students?	A	B	C	D	E
23.	Do you use calculators in class?	A	B	C	D	E
24.	Is your math class taught in small groups?	A	B	C	D	E
25.	Do you get to play games in math class?	A	B	C	D	E
26.	Does your teacher assign you homework to do outside of class?	A	B	C	D	E

THANK YOU FOR HELPING US

Please check to see if you have done the following:

(1) Filled in your name on the answer sheet in the circles.

(2) Have only one answer for each question.

Appendix A-3

TEACHING STYLE INVENTORY

Name _____

1. Almost all help is initiated by students asking for it. ___1
___2
___3
___4
Almost all help is initiated by my seeing the need for it. ___5

2. When students have trouble, I ask them leading questions. ___1
___2
___3
___4
When students have trouble, I explain how to do it. ___5

3. Almost always many different activities are going on simultaneously during math class. ___1
___2
___3
___4
Almost all the time the students are all engaged in the same activity during math class. ___5

4. In class, students frequently work together on assignments. ___1
___2
___3
___4
Students seldom work together on assignments in class. ___5

5. When studying a math unit, students spend some time working in small groups to solve a big problem. ___1
___2
___3
___4
When studying a math unit, students will not be working in small groups to solve a big problem. ___5

6. I encourage students to solve a given math problem the way I have demonstrated. ___1
___2
___3
___4
I encourage students to solve math problems in a variety of ways. ___5

13. Understanding why a given rule or procedure gives the correct answer is important. ____1 ____2 ____3 ____4

    Understanding the rule or procedure is not critical. ____5

14. Almost all my questions in math class can be answered with yes, no, or a number. ____1 ____2 ____3 ____4

    Almost all my questions in math class require the students to give explanations. ____5

15. In my class, I give different assignments to students with different ability levels. ____1 ____2 ____3 ____4

    In my class, I give the same assignment to all students. ____5

16. I usually use a game, story, or challenging problem to provide a context for a new math unit. ____1 ____2 ____3 ____4

    I usually do not use a game, story, or challenging problem to provide a context for a new math unit. ____5

17. I usually start a new math unit by giving examples and showing students how to work them. ____1 ____2 ____3 ____4

    I do not usually start a new math unit by giving examples and showing students how to work them. ____5

PART II STRATEGIES

How frequently do you use the strategy in your classes?

	Very Frequently	Fre-quently	Sometimes	Seldom	Never
18. Whole class instruction					
19. Whole class discussion					
20. Posing open-ended challenges					
21. Gathering and organizing student responses					
22. Encouraging analysis and generalization					
23. Assigning homework					
24. Discussing homework					
25. Using concrete manipulatives					
26. Using games					
27. Drills					
28. Story problems					
29. Non-routine problems					

PART III TEACHER OPINION

Select the appropriate choice for each statement.
A = Agree
B = Somewhat agree
C = Undecided
D = Somewhat disagree
E = Disagree

30. _____I am an effective mathematics teacher.

31. _____I like doing mathematics.

32. _____My basic function as a math teacher is to convey my knowledge of math to the students in a direct manner.

PART IV COMPLETION

33. As of today, I have _____ students that are discipline problems.

34. I assign math work to be done at home about _____ times a week.

35. Think of your average student. When you make a homework assignment, approximately what percentage of the time is it:

_____ completed in class by most students.

_____ begun in class but finished at home.

_____ done entirely at home.
100%

36. When some students do poorly on tests or indicate that they have not understood a topic in math, what do you do?

37. Sometimes students have difficulty solving story problems. Briefly describe how you help your students solve story problems. (Example: I have pupils make drawings or diagrams to help clarify the problem.)

38. As of today, I have _____ students that are chronically absent.

39. When students who have been absent return to class, what do you do to catch them up?

40. List the kinds of manipulatives or educational equipment that you use.

41. How frequently and for what purposes do you use them?

42. How do your students use calculators and computers?

43. How many years (including this year) have you taught math to 6-8 grade students?

_____ years

44. How many years (including this year) have you taught?

_____ years

45. How many hours of college credit in math have you completed (including math methods courses)?

_____ semester hours

_____ (quarter) term hours

MIDDLE GRADES MATHEMATICS PROJECT TEACHER: _____
INTERVIEW I INTERVIEW DATE: _____
TIME: _____

GENERAL QUESTIONS

1. What are the big ideas in 7th grade mathematics?

2. How do you kow when a class period is/is not going well?

   Describe a class period that you thought went well recently.

3. Compare the level of functioning and potential capability of your mathematics students in the following categories:

   MEMORY

   SKILLS

   CONCEPTS

   PROBLEM SOLVING

   APPLICATIONS

   GENERALIZATIONS

4. What motivates your math students to learn the content?

   What motivates your math students to complete their assignments?

5. Comment on the attitudes of your math students towards the following:

   SCHOOL

   MATHEMATICS

6. How important is drill and practice in your math classes?

7. How do you know when your students understand the mathematics content they are taught?

8. Other than math content, are there things you teach your students?

9. What characteristics do you like to see in your math students?

   What characteristics do you like to see in your math classes?

Part II

PROBABILITY UNIT DEBRIEFING

1. As you reflect on this unit would you LIST and DESCRIBE any and all changes you had to make in your usual teaching style.

2. Tell us what you thought about the Probability Unit with respect to the CONTENT and STUDENT LEARNING OUTCOMES.

3. If you were to teach this unit next year what changes would you make? (Changes could mean content, materials, activities/tasks, length, etc.)

4. What, if anything, about the way you taught this unit do you think will transfer to you teaching of other content?

5. As you reflect on the Probability Unit you just completed, would you rate the following experiences as to their value to you in planning for and teaching the Probability Unit in your class(es).

   FROM THE SUMMER WORKSHOP

   A. Overview of the Probability Unit on the first day of the workshop.

   B. Observing the teaching of the Unit with the students.

   C. The discussion and feedback sessions after the instruction.

   D. The readings that were distributed and discussed.

   E. Designing your own activity that reflected the LES Instructional Model.

   FROM THE FIRST SEMESTER

   F. The planning sessions with the coach.

   G. The feedback (oral and written) from the coach.

6. What changes would you make in any of the above experiences you have had so far?

Part III

TRANSFER TASK-1

1. Answer these questions related to your Transfer Task.

   (A) What content did you select for your Transfer Task?

   (B) Why did you choose this content for your Transfer Task?

   (C) What was your goal or objective for the Transfer Task?

   (D) Do you have any other comments about your Transfer Task that you would like to add?

2. As you reflect on your Transfer Task, list and describe any and all important changes you made from the way you taught this content last year. (If you didn't teach this content last year think about the last time you did teach the content.)

3. With respect to teaching the content of your Transfer Task, are you doing anything the same way as you did when your previously taught the same content?

4. What, if anything, about the way you taught the Transfer Task do you think you will use in teaching other content?

5. As you reflect on the Transfer Task you just completed, would you rate the following experiences as to their value to you in planning for and teaching the Transfer Task in your class(es).

   FROM THE SUMMER WORKSHOP

   A. Overview of the MGMP Units on the first day of the workshop.

   B. Observing the teaching of the Unit with the students.

   C. The discussion and feedback sessions after the instruction.

   D. The readings that were distributed and discussed during the workshop.

   E. Designing your one activity that reflected the LES Instructional Model.

FROM THE FIRST SEMESTER

F. Teaching the Probability Unit to your students.

G. Planning sessions with the coach.

H. The feedback (oral and written) from the coach.

6. What changes would you make in any of the experiences (in question 5)you have had so far?

MIDDLE GRADES MATHEMATICS PROJECT
INTERVIEW II

TEACHER: _____
INTERVIEW DATE: _____
TIME: _____

GENERAL QUESTIONS

1. What are the big ideas in 7th grade mathematics?

2. How do you kow when a class period is/is not going well?

   Describe a class period that you thought went well recently.

3. Compare the level of functioning and potential capability of your mathematics students in the following categories:

   MEMORY

   SKILLS

   CONCEPTS

   PROBLEM SOLVING

   APPLICATIONS

   GENERALIZATIONS

4. What motivates your math students to learn the content?

   What motivates your math students to complete their assignments?

5. Comment on the attitudes of your math students towards the following:

   SCHOOL

   MATHEMATICS

6. How important is drill and practice in your math classes?

7. How do you know when your students understand the mathematics content they are taught?

8. Other than math content, are there things you teach your students?

9. What characteristics do you like to see in your math students?

   What characteristics do you like to see in your math classes?

Similarity Unit Questions:

10. As you reflect on the Similarity Unit, list and describe any changes you had to make in your usual teaching style.

11. What did you think about the Similarity Unit with respect to the content and student learning?

12. When you teach the Similarity Unit next year what changes would you make?

13. What about the way you taught this Unit do you think you will transfer to your teaching of other content?

14. Rate the following experiences as to their value to you in your planning and teaching the Similarity Unit.

    FROM THE SUMMER '85 WORKSHOP

    A. Overview of the Similarity Unit on the first day of the workshop

    B. Observing the teaching of the Unit

    C. The discussion and feedback sessions after the instruction

    D. Designing your own activity that reflected the LES Instructional Model

    E. The readings which were distributed and discussed.

    FROM THE SCHOOL YEAR

    F. Planning sessions with your coach

    G. Oral and written feedback from the coach

    H. Teaching the Probability Unit and your first transfer task

    I. Designing your first transfer task

Transfer Task-II:

15. What content did you choose for your second transfer task?

16. Why did you choose this content?

17. What was your objective/goal for the transfer task?

18. Do you have any comments you would like to add about your transfer task? If so, what are they?

19. List and describe any changes you made from the way you have previously taught this content.

20. In teaching the content of your transfer task, did you do anything the same way as you did when you previously taught the same content?

21. What about the way you taught the transfer task do you think you will use in teaching other content?

22. Rate the following experiences as to their value to you in planning and teaching the second transfer task.

FROM THE SUMMER '85 WORKSHOP

A. The overview on the first day

B. Observing the teaching of the Units

C. Discussion sessions after the instruction

D. Designing your own activity

E. The readings that were discussed

FROM THE SCHOOL YEAR

F. Planning sessions with the coach

G. Oral and written feedback from the coach

H. Teaching the Units and Transfer Task-I

I. Designing your own transfer tasks

23. As you reflect on the experiences you have had from the Summer '85 Workshop and across the school year in teaching the two MGMP Units and your transfer tasks, would you list any changes you would like to make that would be more helpful to you as you plan for the coming '86-'87 school year.

24. Would you comment on the Spring '86 Workshop (5/16-17) with respect to its value to you in thinking about your mathematics curriuculum and teaching for next year. Do you have any suggestions you would like to make for the Summer '86 Workshop?

MIDDLE GRADES MATHEMATICS PROJECT
INTERVIEW II

TEACHER: _____
INTERVIEW DATE: _____
TIME: _____

GENERAL QUESTIONS

1. What are the big ideas in 7th grade mathematics?

2. How do you kow when a class period is/is not going well?

   Describe a class period that you thought went well recently.

3. Compare the level of functioning and potential capability of your mathematics students in the following categories:

   MEMORY

   SKILLS

   CONCEPTS

   PROBLEM SOLVING

   APPLICATIONS

   GENERALIZATIONS

4. What motivates your math students to learn the content?

   What motivates your math students to complete their assignments?

5. Comment on the attitudes of your math students towards the following:

   SCHOOL

   MATHEMATICS

6. How important is drill and practice in your math classes?

7. How do you know when your students understand the mathematics content they are taught?

8. Other than math content, are there things you teach your students?

9. What characteristics do you like to see in your math students?

   What characteristics do you like to see in your math classes?

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10. As you reflect on the Similarity Unit, list and describe any changes you had to make in your usual teaching style.

11. What did you think about the Similarity Unit with respect to the content and student learning?

12. When you teach the Similarity Unit next year what changes would you make?

13. What about the way you taught this Unit do you think you will transfer to your teaching of other content?

14. Rate the following experiences as to their value to you in your planning and teaching the Similarity Unit.

    FROM THE SUMMER '85 WORKSHOP

    A. Overview of the Similarity Unit on the first day of the workshop

    B. Observing the teaching of the Unit

    C. The discussion and feedback sessions after the instruction

    D. Designing your own activity that reflected the LES Instructional Model

    E. The readings which were distributed and discussed.

    FROM THE SCHOOL YEAR

    F. Planning sessions with your coach

    G. Oral and written feedback from the coach

    H. Teaching the Probability Unit and your first transfer task

    I. Designing your first transfer task

Transfer Task-II:

15. What content did you choose for your second transfer task?

16. Why did you choose this content?

17. What was your objective/goal for the transfer task?

18. Do you have any comments you would like to add about your transfer task? If so, what are they?

19. List and describe any changes you made from the way you have previously taught this content.

20. In teaching the content of your transfer task, did you do anything the same way as you did when you previously taught the same content?

21. What about the way you taught the transfer task do you think you will use in teaching other content?

22. Rate the following experiences as to their value to you in planning and teaching the second transfer task.

FROM THE SUMMER '85 WORKSHOP

A. The overview on the first day

B. Observing the teaching of the Units

C. Discussion sessions after the instruction

D. Designing your own activity

E. The readings that were discussed

FROM THE SCHOOL YEAR

F. Planning sessions with the coach

G. Oral and written feedback from the coach

H. Teaching the Units and Transfer Task-I

I. Designing your own transfer tasks

23. As you reflect on the experiences you have had from the Summer '85 Workshop and across the school year in teaching the two MGMP Units and your transfer tasks, would you list any changes you would like to make that would be more helpful to you as you plan for the coming '86-'87 school year.

24. Would you comment on the Spring '86 Workshop (5/16-17) with respect to its value to you in thinking about your mathematics curriuculum and teaching for next year. Do you have any suggestions you would like to make for the Summer '86 Workshop?

THE MIDDLE GRADES MATHEMATICS PROJECT

THE CHALLENGE: GOOD MATHEMATICS--TAUGHT WELL

FINAL REPORT TO THE NATIONAL SCIENCE FOUNDATION FOR GRANT # MDR8318218

Appendices B, C, D

SE 049 107

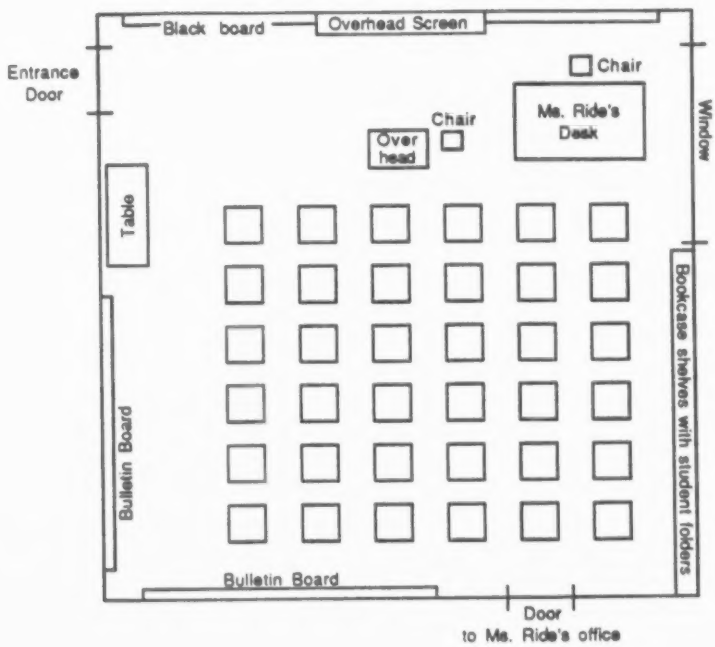
Appendix B

Laura Ride: A Case Study of a Lead Coached Teacher

Laura Ride's Classroom Prior to the MGMP Project Intervention

Laura Ride had been teaching middle school mathematics for 11 years when she joined the Middle Grades Mathematics Project. She has an undergraduate teaching major in mathematics with secondary certification and a master's degree in education. She teaches mathematics and is the mathematics department chairperson at an inner city middle school with a large minority population. The middle school is one of four that serve the school district for a city population of over 250,000. The school has 6 periods each of which is 50 or 55 minutes long. Laura teaches four classes of seventh graders, two regular and two enriched, and because she is department chair has two planning periods.

Laura's classroom has 36 chairs arranged in six rows of six chairs each. Students have assigned seats. The following diagram shows the room arrangement.



Laura makes daily use of the overhead. The chalkboard is mainly used for recording homework assignments, future due dates or upcoming events. She teaches primarily from the front of the room.

Her walls are covered with posters on one side and math related bulletin boards on two side walls. Student work is kept in individual folders which are passed out by student help at the beginning of class. Papers are passed out by rows.

In May 1985, prior to the beginning of the MGMP intervention Laura's class was observed three times. The intention of these observations was to provide a baseline snapshot of Laura's mathematical orientation, instructional mode, her questioning technique, classroom interaction patterns, management style, typical lesson construction, and typical class routine. The observer was asked to write an inferential summary of Laura's instruction, based on the three observations, to include observed strengths and weaknesses. Quotes from this summary document begin our picture of Laura Ride, seventh grade math teacher.

> Laura's class creates a sense of energy explosion, with lots of activity, talking and bantering teacher to student, student to teacher, student to student. The students and teacher were alive with comments flying every which way and always an almost uneasy sense of "will this get out of hand?" The teacher always seemed to be in control and fielded comments back into the class, but often had to call for silence, and repair the classroom scene. The students always complied for a reasonable amount of time. There was a sense of "every-man-for-himself" in this class and yet there was a strange feeling of acceptance of each other underneath it all. The teacher seemed to genuinely like the students and the students did seem to care for the teacher but as person to person, not as teacher to class or student to teacher.
>
> In the three times I observed I witnessed the teacher as very happy, alive and tolerant; very edgy, sharp, and intolerant; willing to banter and play the game; unwilling to banter and very businesslike. The students tried to pick up her manner and adjust as quickly as possible. Some were quicker than others. There seemed to be a "point-beyond-which" everyone knew they had better not go but they certainly pressed to the limit.

Here we see a picture of a teacher with a strong personality; she seems to be aware of herself as a black role model for her students, many of which are black. She uses black dialect in her informal social interactions with the students before and at the end of class and when interruptions occur. She dresses very stylishly and uses her dramatic flair to energize lessons.

Laura's typical flow of activity in a class is captured in this quote from the baseline observers summary.

> The teacher taught from an overhead projector in the front of the room and kept up a very fast paced presentation. She would read off the answers to homework first. She would field questions briefly and then begin the presentation. She spoke very quickly, asked many questions with short answers, and worked several examples.
>
> Laura would proceed from instruction into practice by going through exercises in the book, going around the room so everyone had a chance. She also tried to keep this fast moving, yet often asking a student to explain the answer given. The students were never seen working together on math and only occasionally was conversation between students recognized as math oriented.
>
> When they were given seatwork it was understood that they worked individually and quietly. Laura would walk around the room and seemed to stop by those she expected to be having difficulty.

One unusual aspect of Laura's instruction is that she is willing to spend large chunks of class time in direct instruction or interaction with the students. For the three baseline classes she spent an average of 35 minutes of her 50 minute period in direct instruction. There is evidence in the observer's field notes that Laura talks about student "understanding" but for her "understanding" means a procedural-computational orientation. These vignettes are from observations of lessons on integers.

> The teacher asked the first student in the first row what he got. The student gives the wrong answer. The teacher asks him how he got his answer. The student said that he added the numbers together. One of the numbers was positive and one negative. The teacher said, "Think of your number line." The teacher then shows the number line. The teacher said, "Think of your rules." The class had worked out the rules yesterday. The teacher then asked the students, "If one's negative and one's positive what do you do?" The teacher goes over the rules for addition of integers on the overhead. She then works some examples for the class.

and,

> The teacher said, "Here is one that will take you a long time to accept." The teacher said, "Maybe next year you will understand this." The teacher said, "You will have to accept that this [-2 x -3] is a positive six." ...The teacher said, "Very quickly. I know you are not going to understand this. You must accept this."

The teacher then tried an explanation that looked at opposites to show that the opposite of a

multiplication problem is the opposite of the answer to the multiplication problem. She got an incorrect answer and then said,

> "I blew it... "You're going to have to accept this" (Laura writes on the overhead)
> (+) x (+) = (+)
> (-) x (+) = (-)
> (+) x (-) = (-)
> (-) x (-) = (+).
>
> Laura proceeded to the rules for division of integers but related these to multiplication for the students.
>
> [Laura writes on overhead while explaining]
>
> 2 x 3 = 6
> related ÷ (related division facts)
> 6/2 = 3 6/3 = 2
>
> 2x -3 = -6
> related ÷ (related division facts)
> -6/2 = -3 -6/-3 = 2
>
> "I want you to see the relationship between the multiplication and division."
>
> -2 x -3 = 6
> related ÷ (related division facts)
> 6/-3 = -2 6/-2 = -3
>
> The teacher asked the class if they believed what she had put on the overhead. One of the students said yes. The teacher said to the class "Do you understand it?" One of the students said, "No. Not really."

Laura tries to help her students see connections, as this example illustrates, but when these connections are confused by the students, she does not help them sort out their misconceptions. The next day a student argued with one of the answers to the homework.

> He said, "You said a plus times a plus is a negative. It's on the chart." The teacher did not respond to what he said but kept saying two times three has always been six. The teacher said, "Don't argue with me."

A Teaching Style Inventory was taken in the spring before the intervention by the teachers in the project. This gives us a baseline self-report record of Laura's thoughts about various aspects of teaching. The questions on the inventory can be grouped into four categories: questioning, organization, expectation, and teaching strategies. Laura sees herself as asking questions that vary between those that can be answered with yes, no, or a number and questions requiring students to give explanations. When students have trouble Laura asks leading questions. She agrees with the

statement that almost all help is initiated by students asking for it.

Laura's response on the organization questions show that during math class she has all students engaged in the same activity; students work individually; group problem solving is not used; some rearrangement of furniture may occur; all the students are given the same assignment; and she mostly uses the same teaching approach throughout the semester. Laura says she encourages students to solve problems in a variety of ways. She does not expect them to use only what she demonstrates. She mostly emphasizes concept development as opposed to computations, yet she takes a middle position on the importance of understanding why a given rule or procedure gives a correct answer.

Laura portrays herself as mostly using an inductive method of concept development--the concepts are derived from a series of similar problems. She takes a middle position on whether or not topics are revisited. She frequently tries to related new ideas to previously learned ideas. She does not use games, stories or challenging problems to motivate new units. She always starts by giving examples and showing students how to work them.

Laura portrays her teaching strategies as whole class instruction with frequent discussion. Homework is assigned and discussed each day. Open-ended challenges, concrete manipulatives and drills are sometimes used. Story problems are frequently assigned. Non-routine problems, games and student explorations are seldom used and yet students are frequently encouraged to analyze and generalize. She sees her basic function as a math teacher as conveying her knowledge of mathematics to the students in a direct manner. She lists meter sticks, scale, volume containers, rulers and protractors as the manipulatives she uses and the metric unit as the purpose for which she uses manipulatives. Calculators are used occasionally to help solve word problems.

The observation data and the self-report data are in agreement on most aspects of Laura's classroom and teaching. She asks many questions and pulls her students along with her (at times by the force of her own personality.) She does not encourage or deliberately organize student to student interactions. One major area of disagreement in the evidence is the focus of the teacher. Laura perceives herself as a conceptually oriented teacher who values student understanding. The evidence in the field notes and observer summary indicates that she has more of a procedural, computational

focus. One explanation is that at this stage Laura has not perceived the difference between a student "explanation" that consists of a repeat of the steps of a rule or procedure and a student "explanation" that tells why the rule or procedure works. The textbook is the main vehicle for instruction. Manipulatives are used only for the measurement unit.

Summary

The picture we have of Laura prior to the intervention is that of an alive, energetic teacher. She has good rapport with her students. She has a caring attitude. She tries to lead them into the content emphasizing relationships with past work. The students are responsive in class and seems to like being there. Areas of concern for the classroom coach are that the banter with students at times overrides the content. She tends to be rule oriented and does not encourage student initiative. She asks many questions, but these tend to be short answer, not open ended, and call for little more than the giving of a number answer or rule. The baseline observer predicted that having students work together productively or giving students more opportunities to take initiative with the mathematics would be a difficult change. She noted, ..."promoting the conceptual aspect of mathematics would appear to be a challenge for this teacher."

Middle Grades Mathematics Project: The First Intervention Year

During the first year the intervention consisted of a two week summer workshop and two cycles of practice, (teaching an MGMP unit) followed by a Transfer Task (developing and teaching a unit). In the first semester each teacher taught the MGMP Probability Unit and a unit they had individually developed. In the second semester they taught the MGMP Similarity Unit and a unit they developed. The project had a Christmas Party and a 1 1/2 day pull-back session near the end of the school year. In addition Laura was among the group of teachers that was coached by a staff member throughout the first year.

The Summer Workshop:

The activities of the summer workshop were 1) a one day overview of the content (mathematics and methodology) of the two MGMP Units that would be taught during the year; 2) observations each day of the teaching of these units by the staff to a class of 30 middle school students: 3) daily

discussion sessions on the observed teaching; 4) reading reports from the literature that related to the goals of MGMP; and 5) practicing the development of a sample transfer task unit. In the first interview when Laura was asked to rate the activities of the summer on a scale of 1 to 5 (not helpful to very helpful), she gave each aspect of the Summer Session a 5. She noted,

> I think the experience this summer was just very, very good ... very well done. It's made a difference in my attitude and I think that would go for all the teachers attending.

In the first conversation with Laura in November 1986, she said, "You have really changed my life. I am looking for concrete manipulatives and using representations and models to help understand." She went on to explain that for ten years she had modeled her teaching on what she had seen in her classes--check homework, give examples, assign homework straight from the book. She said that in the past few years she had begun to see this as a very sterile view of her role as a teacher. She said "I don't know why I was so willing to take that as a model to try to live up to. Why didn't I question it?" She said that she had been "looking for something else" when she went to the MGMP summer training session.

The staff observations of the teachers agree with Laura's comments. She was one of the most vocal, questioning of the 12 teachers during the 1985 summer session. The meaning of her reactions to the summer session were not so obvious to the staff. One interpretation of her behavior during the summer could have been "resistant to such radical changes." As our coaching sessions proceeded during the year the picture that emerged was one of a teacher eager to change, eager to focus on conceptual understanding, but scared -- especially in her role as department chairperson of a large inner city school -- that the changes would not be successful. The pressures of the accountability of district and state testing programs which focused on computation caused her much anxiety. This anxiety at times made her questions and comments in large group meetings seem almost belligerent -- almost demanding assurance that this would work.

Teaching the MGMP Probability Unit:

I observed two classes before our planning session for the Probability unit. In these two lessons Laura was teaching decimals. The lessons were focused on developing the meaning of

"decimal numerals"; comparison >, =, <; and simple addition. Laura was using multibased blocks, with the 10 x 10 x 10 cube as the unit to represent decimals. She also used decimal squares and shading to present problems pictorially to the students.

At our first meeting she seemed pleased with what she was trying to do, but frustrated that the students didn't score as well as she hoped on her more conceptual tests.

Other observations about Laura in these two days before the 1st unit:

* She still used large chunks of time for direct instruction.

On these two days she used an average of 35 minutes of a 55 minute class for direct instruction.

* She is willing to stick with a student that she called on trying to help them figure out a more correct answer.

* She cared about correct mathematical language as evidenced by "decimal numeral" but was not always careful such as reading .07 as "point zero seven" rather than as "seven hundredths."

* Her colloquial language use might have distracted from the mathematics. "Talk to me baby" was used in calling on students. It was hard to judge the impact on students.

The following write up of Laura's planning-coaching session is included to show the early stages of our working to define what our relationship would be. This report was written immediately after a session on November 6.

> Laura asked me to give her an overview of the unit. She said she felt shaky on the lottery. She questioned whether she knew enough to do a good job of it.
>
> I talked about the three parts of the unit: fair games, area, and binomial probabilities. I reminded her that she had choices on what to include and leave out and how to structure class and grading.
>
> I talked about the necessary parts of Activity 1: definition of probability, range of probabilities, and sum equal to one. Laura said she new the lottery could serve as a motivator for the kids, but she only has two weeks. She raised the question of whether or not she could make a smooth transition from the definition in activity 1 to the first game in Activity 2 if she left out the lottery. We discussed this and made a plan to do this, with her trying in the definition to both the experiment of the 2 coins game and its mathematical model. She seemed to see that this could work and was pleased.
>
> I think she is presently worried about the mathematical concepts in the unit. She asked what she could expect from me once the unit started. I asked what role she wanted me to play and she replied that she wanted me to actively participate. I said I was willing to do whatever she was comfortable with. We agreed that I would move around helping groups to give us insights to talk

about in our coaching sessions. I said: "You can even throw the ball to me if you choose." She said: "Oh good. I wanted to know how you felt about that." I suggested that I would even teach a lesson, except 6, 7,8, if she ever felt it would be helpful.

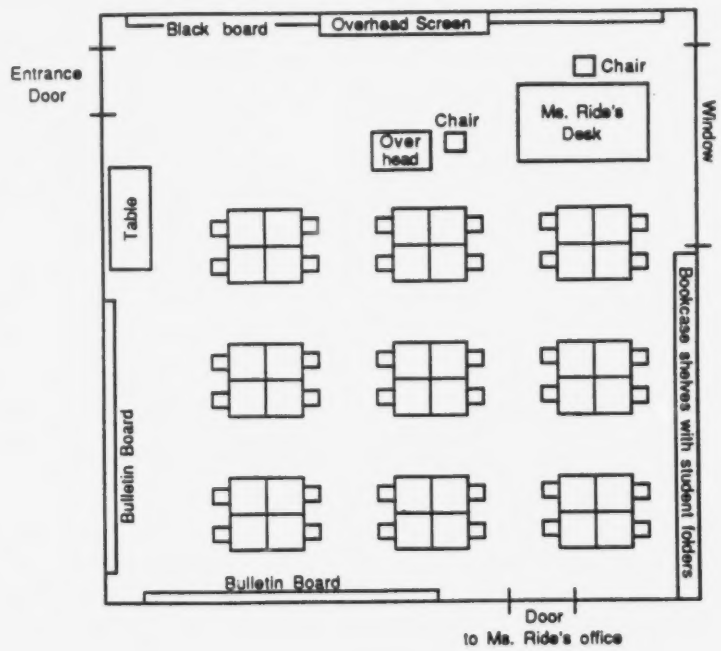
She asked about the observer and could she see the notes. I said that I would be using information from that data in our coaching sessions and she was pleased. She said she wanted feedback.

We planned the first three days and set a target goal of Activity 6 on Monday November 18. I closed by reminding her of the importance of a conceptual focus during the activities. We talked about the difficulty kids have with counter intuitive notions in probability. The last thing we discussed was room arrangement, grouping and noise level during the units. She had planned four person groups and has planned to rearrange desks on Friday. Laura likes quiet. She said that she has noticed that when she visits other teacher's classes the noise level never bothers her, but in her own she feels that the same noise level never sounds louder! She was being amused at herself. She said that she felt that she was very different from last year in her teaching. She said she had had students come by and say "Laura, you never did that for us last year!" Apparently her conceptual modeling is being talked about among the kids.

She said that the chance to observe others teach was the most mind opening experience she had ever had. This summer was one of dissonance and new directions for her. For the Probability unit Laura arranged her chairs by turning each four together to make a group arrangement as illustrated.

She began by establishing ground rules for activity work. There was a real excitement in the classroom. The class I observed was her smallest class. They are of "average" ability. Some of the students are discipline problems in the school. Absentism is high.

The following diagram shows the new room arrangement.



Two excerpts from the field notes show Laura in two different kind of questioning situations. In the first excerpt Laura is directly modeling how to analyze the Basketball Problem to find theoretical probabilities. Here she uses frequent short answer questions to keep students attention focused. Her questions are basically low level requiring automatic responses from the students.

> Teacher: "Let's check our experimental results. Your total number of trials is 260. So the probability of 1 point is 65/260, of 0 points is 106/260 and of 2 points is 89/260. So the most probable is what? 0 or 2 points? That's not what we expected. What did we say we'd get most often?" Student: "1 hit." Teacher: "But this came out the opposite." Teacher: Do this
>
> "106 divided by 260 = .41
> 65 divided by 260 = .25
> 89 divided by 260 = .36"
>
> Teacher: "Those are the decimal equivalents of those probabilities." Teacher: "I want to show you another way, theoretically. Look at your second page. Let's see what we're suppose to come up with. Remember the area models we did before? When we did that not long ago? If Terry is a 60% shooter, 60% of the time she'll make it. How often will she miss it?" Student: "40." Teacher: "How can I divide up my grid to show her hits and misses?" Student: "Draw a line between the 6 and the 7." Teacher: "One column represents what?" Student: "1/10." Teacher: "One column equals 1/10 and two columns equal 2/10. So I'm going to count over 6 columns and draw a line. I want you to do this because you're going to do the rest for me." (Teacher models this on overhead).
>
> Teacher: "Okay if she misses the first one all of this is 0 (teacher illustrates on grid). If she hits the first shot, what's the probability that she'll hit the second? It' 60% -- so I'll count down 6 more boxes and draw my line. This represents hit and this is the miss. If she hits the 1st and second how many points?" Student: "2." Teacher: "Right. So all that area I give 2. (Teacher marks grid). So, we're ready to figure the probability of getting 1, 2, 0 points. So whats the probability of her getting 2 points?" Student: "40." Teacher: "Of getting 1 point? How many squares?" Student: "36." Teacher: "Let's compare that to our experimental results. Does it come close!! We got 41 hundreds and we're supposed to 4.0 -- we did good. Our experimental and theoretical came real close."
>
> Teacher: "If I were a coach I'd want to know long range what to expect. Do I always expect her to get a 0?" Student: "No." Teacher: "Do I always expect she'll get a 2?" Student: "No." Teacher: "So we want to figure out her average to find out the long range points. What do we need to do to find an average?" Student: "Total points." Teacher: "We need total points and then what when we find averages?" Student: "Divide." Teacher: "Right. By what?" Student: "Number of trips to the basket." Teacher writes this on transparency:
>
> Ave. points =total points/trips
> Teacher: "If she went 260 times to the basket ... How many points is that when she makes 89 trips?

106 times 0 = 0 points
65 times 1 = 65
89 times 2 = 178

Student: "2 points." Teacher: "So 89 times 2 will tell us -- how many? Student: "178." Teacher: "What's my total? (teacher adds it) 243." Teacher: "To find an average we divide 243/269 and get what? Push it in the calculator." Student: "93." Teacher: "What points will she get?" Student: 93." Teacher: "93? That's .93. What is that so close to?" Student: "1." Teacher: "Yes she'll come close to 1 point per trip."

In this second excerpt below Laura is exploring with students in a more open ended way. Notice the comment on "determined to get through it". At the end of the period the lesson returned to a race with the clock. Her last words before dismissal were, "The bell will beat me. I want you to figure these out for homework tonight." Task completion seemed to be a real goal with Laura.

Launch: Teacher: "Let's get started. Today's activity can take a lot of time, so I need your attention because I'm determined to get through it."

Setting the context: "Sue collects $5.00 from her paper route customers each week. One of her customers wanted to make it more interesting. (Animated) He said, 'I'm going to put a $10 bill and 5 $1 bills in a bag. Each week you can draw 2 bills out, instead of taking the $5.00.' Would you do this or would you go with the sure thing?"

Student: No, most likely she'll get $2." Teacher: "She'll either get $11 or $2. The question is will she make $5 average over time? It's kind of hard to tell. Two weeks might be too short a period of time to see if it will even out. Maybe we need more time. How many say she'll make money on the deal?" 12 hands raised. Teacher: "How many say she'll lose money?" 3 hands raised. Teacher: "How many say break even?" Student: 4 hands raised. "How can we help Sue decide?" Student question: "Will he add money every week?" Teacher: "Yes, every week he'll have a $10.00 and 5 $1.00 bills in the bag." Student comment: "I think she'll get $1.00 so I think she loses over time." Teacher: "So is this our vote? (referring to tallies on overhead). I heard 3 didn't vote. You have to make decisions to go places in this world. How can we help her?"

Student: "Simulate it." Teacher: "We should play the game. How can we simulate it?" Student: "Get a paper and mark $10.00 on it and 5 $1.00." Teacher puts 5 one dollar bills and 1 ten dollar bill in a bag. 'Let's act it out and see what we get. We could draw $2 or $11. I'm going to do it for 6 weeks." Teacher has one student draw as another student records results on overhead. Student: "$11." Teacher has another student draw. Student: "$2." Teacher has another student draw. (Teacher makes sure to shake bag each time). Student: $11. Teacher: "Another draw from a student." Student: $2. Teacher: "Is she making or losing money?" Various answers. Teacher: Another student draws. Student: $2.00.

Teacher: Let's see what she got, $2 times 4 or $8. She got $11 twice or?" Student: "$22." Teacher: "What's the total?" Student: "$30." Teacher: "How many weeks did she do it?" Teacher: "This is sweet. (Teacher excited when she sees it will break perfectly even). What happened?" Student: "She broke even." Teacher writes on board:

$$\text{Average} = \frac{\text{total money}}{\text{number weeks}}$$

Teacher: "Should she take the deal?" Student: "Yes." Teacher: "Is 6 weeks long enough to really tell?" Student: "No." Teacher: "Okay we'll do it for 30 weeks. We've worked at many different simulations (points them out). How could we simulate this (situation)?"

Student: "Put 5 $1.00 or 1 $10.00 in squares and have her put her finger on one square." Teacher: "How will that be random?" (Teacher draws square on the overhead) How will we make that random? We don't want her to put her finger in the same place. Think there is a better way?" Student: "Like pin the tail on the donkey. With circles within the circle. 10 will be in the middle and one dollar will be in the circles on the outside." Teacher: "How do you get random results? I'm not sure that will work, because of something about the areas of those circles, besides we're not going to throw darts in class." Student: "Have people each hold a bill and have a blind folded person pick one." Teacher: "That might work. What about stuff we've done before?" Student: "Spinner ..." (Student talks about setting up a spinner with equal parts). Student comment: "You could land on 10 twice if you did it that way." Teacher: "Yes we need to make a decision about that." Student comment: "If you could use a 2 sided arrow then you'd have 2 different points." Teacher: "Let's say when you spin, anytime you land on $10 it's an $11. If you land on 1, you spin again." Teacher: "When I was shaking these up what was wrong with that? Was I really getting a good mix?" Student: "No." Teacher: 'How would you use ping pong balls?" Student: "Label them one with $10, five with $1." Student: "If you had coins, you could use a dime and pennies." Teacher: "Is there a problem with that? Dimes are smaller so you need same size coins." Student: "You could use dice -- even numbers are $10 and odd are $1.00." Teacher: "Is there a problem with that?" Student: "The odd would come up most often." Teacher: "We need to know what the probability of rolling those numbers is. I don't think it will work with 2 dice. How about 1 die?" Student: "If you roll twice ..." (Student explains his strategy). Teacher: "What else could you do?" Student: "You could use one color for $11 and another for $10." Teacher: "I've got green dice, red and white dice. Some colors of dice are smaller than others. Would I want to mix them?" Student: "No." Teacher: "No you have to use the same size to make it random."

In the first interview Laura shows that she is struggling with her use of time and with what she can reasonably expect of students.

I took two weeks out of the curriculum to do Probability. The rest of the teachers in the department didn't take that time. They used that time to go on in the curriculum. Well what I found myself doing is pushing everything at my students I possibly could within the same time frame and the same concepts. I'm wrestling with the idea, I know what we're doing is important, I know building concepts is important, but I know there's also another way I can get the kids to show me on the test that they can do it. But I'm hoping that the payoff is going to be that if they understand the concept they're going to remember it a little bit longer. And they should be able to demonstrate it. So I'm waiting on that payoff.

I can feel from the students that their participation is greater and that they're more involved then they're gonna probably learn those

> concepts a little bit better. Maybe I'm expecting some drastic changes. and it's not that I'm doing anything so terribly different than I did last year. And I keep expecting things to significantly change.
>
> So much of what we did in the Probability Unit, I do normally, but I might not orchestrate it as efficiently as that unit was laid out ... I would transfer developing concepts and asking questions so that the students are able to come up with things as opposed to me giving them the answers. I still develop concepts with students. I've done that. I may not have done it as thoroughly as I do it now and sacrificing time for them to get some homework done. I might spend the entire hour trying to develop a concept, now, and not worry about the homework so much. Grouping is something that I still have to work with and I have to learn to recognize when I can group students for an activity...

The period immediately after class is a planning period for Laura. We were always able to have our coaching sessions immediately. They lasted from 20 minutes to a full hour depending on need. The following is a dialogue that I recorded immediately after the first MGMP lesson. It shows that Laura is pleased but having some problems with the mathematics. Whenever the teachers were uncertain of the mathematics this made discussion of other issues very secondary.

(C = Coach; L = Laura)

C: How did you feel about how it went?"

L: "It went well all day. I wonder if I did too much acting and poured too much on them. I'm not sure they were all with me."

C: "I thought the pacing was good. You quickly called on students and kept things moving during the launch. What would have happened if you had slowed that pace?"

L: "They would have been bored and chaos would have broken out."

C: "This class has a small number. How did it go in your larger classes?"

L: "In last hour every seat was filled and it was great. They came up with good answers and really caught on. I did not get as far through."

C: "Did you plan your list of rules for activity work before 1st hour or was it a result of the day's experience?"

L: "I knew I had to let them know what I expected of them in these new arrangements."

C: "How do you plan to handle homework?"

L: "I haven't thought about it. I was too nervous getting ready for today. Last night I dreamed about probability."

C: "How do you feel now?"

L: "Not nearly so nervous."

C: "Let's look over what you assigned and anticipate student problems."

L: "I see that I forgot to stress the "not " in this class. They'll have trouble."

C: "How do you usually handle homework when the students have problems?"

L: "They expect me to discuss it."

C: "Then you should, probably, look over this sheet and select the problems you want to discuss or it will eat up the whole period. There is a lot here."

L: "Yes. I'll do that. Do you think the kids got the fair game example? They seemed to have trouble with making it fair?"

C: "You have to decide whether what you want is to open up the problem to a discussion of any change that will make a game fair or whether you want to focus on point adjustment. Then ask your question in that way -- "How should I adjust the points to make it fair?" Or "How can I change this game to make it fair?"

L: "They didn't seem clear on the difference between the probabilities and the points. I didn't do a good job of that."

C: "Let's see -- for future reference you could have taken the total match and no match and rewritten those as points:

Player A's pts = # of matches	54 Points
Player B's pts = # of no matches times 2.	54 x 2 - 110 pts.

Looking at 54 versus 110 points scored suggests that Player B gets 2 times too much. That might have helped. The data really came out well."

L: "In another class it was weird."

G: "One group can really skew the data if they do not flip randomly. We also have no guarantees in probability! Maybe you should go back to this game to launch your theoretical probabilities tomorrow. This one has an easy tree and that would allow you to list the points problem again.

L: "That looks good."

C: "Don't hesitate to call if you are puzzled by anything."

L: "Okay. Great."

One problem that cannot be ignored is the physical stamina needed to teach in such a demanding way

for several periods a day for several consecutive days. By noon after the fourth period, on the second day, Laura was tired. She is always honest with the kids, but her honesty at times sends signals that the mathematics is hard or boring or just something to be endured. A typical comment when she is tired is "The only way we are going to make it through this hour is for you to not touch the chips until I tell you to. I repeat ..."

At this stage the "activity" is threatening to outshine the mathematics. In my coaching suggestions we talked about maintaining a focus on the mathematics. This can be done through questions asked of the kids. I encouraged her to concentrate on pushing students to answer "How did you get that?" "How were you thinking?" "Why?" And such questions.

Laura is always very interested when I use student specific references in our sessions. I told her two stories about Sammy's comments in class. Sammy is a cute, very small, very active white student who has been moved back from the gifted class. He and his partner spent a lot of time on talking -- but 90% of it was on probability. Laura said that she always assumed that when the kids talked it was not about math. She is surprised at my reports of student-student interactions.

Pacing is a bit of a problem. I talked about the tightrope we walked between persistence and pacing. I told her it was o.k. to pick up the pacing in such cases, since she knows that she will have many more opportunities in the unit to pin down students' thinking.

As the unit progresses, Laura reports the feedback she is getting that shows the class interest. Her 3rd period (large class) didn't want to leave at the end of one day because they weren't finished. Many staff members have wandered by to see her teaching.

Here is another dialogue from a coaching session at the end of week one of probability.

(L = Laura; C = Coach)

L: "Oh, I felt like I was pulling teeth. They weren't with me. In the other classes I got much further and felt good about it."

C: "Why did you feel that you had to do it a bit differently in this class?"

L: "I felt they weren't quite ready. Their answers showed that they were having trouble so I went over another example."

C: "Isn't that the kind of sensitivity that teacher's always have to have to individual classes?"

L: "Yes, I guess so."

C: "How do you feel about this class' understanding now?"

L: "They are doing much better on trees and on writing experimental probabilities. They saw the hump in the center of the graph. But look at the graphs I was able to do in 1st and 2nd period. (She showed me graphs of sum and product games that took 1st period alone and 1st and 2nd period together. Very good representations of expected curves.)"

She had obviously spent a lot of time preparing and seems very solid on her understanding of the math content. She is beginning to focus on why and to let the mathematical questions drive the summaries.

We talked at length about discipline. I asked how she had developed her style. She said that she had worked very hard over the last two years to stop losing her temper and shouting at the kids.

I pointed out the times she had reinforced positive behavior and the ways in which she had tried to bring wandering students back on task without disrupting others but by also putting the responsibility for proper behavior on them.

I asked if this was conscious and she said yes she had been working hard on improving her skill in this management area, but she recognized that her need to have every student's eyes at the front was probably too strong. She said she knew that maybe students could look somewhere else and actually think about what she is asking but she still strives for everyone's active attention.

She said that her husband had had a hard time understanding why she felt that she had been so affected by MGMP this summer.

L: "I was looking for something. I was really ready. Then what I saw you doing this summer challenged what I had been doing for years. I was one of those 'so you haven't learned to add decimals! Well you line up the decimal and ...' I have found out that manipulatives and modeling don't take as much time as I feared. I feel that I have found effective ways to use them to build understanding. I feel like my students are building ways to test what they're doing. I may not have covered dividing decimals yet, but I feel that they have some conceptual knowledge that other classes aren't getting. I can't wait til the first monitoring exam to see how they are different. I feel good about what I am doing. This probability unit is really pulling things together for the kids in the first 3 classes, not quite so much in this one. In those classes the students are using decimals constantly to compare probabilities."

I commented on her obvious attempts to relate things to what kids have done before (and she noted)

L: "Yes. I'm trying to help them get the big picture. You know, everything I have read since last summer reinforces and fits what you all were talking about. I feel like it is all coming together for me."

For a while Laura had trouble with the Explore phase of the Activities. She frequently fell into a discipline role and spent her time repeating directions. We began to work on trying to get her to listen to the students during the explore and to react to opportunities presented by the students to question them on their thinking. This coaching record shows her beginning to pose extensions during an exploration. The report was written after Activity 7, the Basketball Problem.

> Laura said, "I felt the lesson was very good." I agree. I said that she seemed to own this one. She laughed and said she had dreamed about it. At 4:30 a.m. she was awake thinking. "How am I going to get those little darlings to understand this?"
>
> She said she had been afraid she would have to hover over the script. Instead, she barely looked at it during the lesson. This made her feel good. She clearly liked this activity and felt on top of it.
>
> She said, "I am surprised that the class stayed with me the whole 55 minutes." I emphasized:
>
> (1) Cohesion brought to activity by her story setting.
>
> (2) Her advanced organizers for kids (we are going to do (1), (2), (3), etc.
>
> (3) Her care to always "look back" and interpret answers relative to the original problem. "What does this number we found mean?"
>
> (4) Her pacing, today, which allowed her to attend to individual needs of students. She gave an extra challenge to two groups within my hearing. She was also able to get a couple of kids straightened out in their thinking.
>
> Then we talked through Activity 8. I pointed out the subtlety of the drawing without replacement -- the difficulty kinds have with listing TO_1 and/or 0_1T, the importance of letting students decide on (or at least be in on planning) a simulation for the paper problem.

Laura, as do many teachers, questioned whether or not students could handle the Probability Unit. She underestimates students' ability to think about difficult mathematics concepts. In a coaching session toward the end of the unit she revealed how her thinking on this was changing. This is an excerpt from a coaching record:

> Laura commented on how important it had been to her to have someone to talk to about the unit. She said that she expected that a teacher would look at the script and see a fraction and say "My kids can't do this."

> They need to see how the kids can think before they are willing to take the risk. Fractions haven't slowed my kids down a bit."

Laura's thoughts about teaching and her actions in the classroom ar not totally together. Throughout the unit she has had days which were excellent and other days when the "let's get this covered" computational teacher reappeared--days when she put the focus on the students discovering the mathematics and days when she "told" them what to do and think. I would characterize her as a teacher in transition with not a lot of consistency in her manner to the class. Her strengths are her "acting" ability which makes her Launches real attention getters. She knows about students' need to have mini challenges modeled and generally does a good job of launching. She frequently tries to relate new ideas to students' past experiences and knowledge. In spite of her volatile temper, her caring for her students comes through. She is willing to stick with a student until he/she has a measure of success. Her concept of her role during exploration is a problem. Explores are frequently short and not focused on the underlying mathematics. Activity is taking place but students do not always know what the underlying question is. Pacing at times is too slow and questions are not thought provoking.

First Transfer Task

The project staff had as a major question to determine the amount and kind of help teachers need to not only teach a unit of the MGMP materials but to also learn from this experience strategies for planning, selecting tasks and materials, organizing activities, and teaching that would be transferable to other parts of the curriculum. The transfer tasks were designed to focus the teachers' attention on moving beyond the practice phase (teaching an MGMP unit) to considering how to organize their instruction in general in such a way that students focus on concept development and seeing relationships among concepts (and related skills and procedures). This part of the case study focuses on Laura Ride's first attempt to transfer teaching ideas and strategies from MGMP to a unit of her own design.

Laura planned the transfer task on her own. She chose integers as the topic. This was an especially good choice from the project point of view, since the baseline observations from the spring before focused on Laura teaching integers. Here is an excerpt from the field notes that shows a major

difference from the first observations.

> Teacher: "Again let's use our head about addition problems with integers. These are exactly the same as we just did. If you receive $5 that's a +5. If you pay out $2 that's like a-2. So are we ahead by $3?" (Teacher does problem 1 on assignment sheet I). Student: "Yes." Teacher: "If we receive $3 and pay out $4 can you see we're behind $1?" Student: 'Yes." Teacher: "The next one,we receive $6. That's +$6. We pay out $4 that's -4. Will we be ahead or behind?" Student: "Ahead." Teacher: "Yes ahead by $2. The next one we receive $1. We pay out $3. Are we ahead or behind?" Student: "Behind." Teacher: "Yes behind by $2."
>
> Teacher: "If you receive $6 and pay $4 are you ahead or behind? How many think you'd be behind?" Student raises hand and says: "Okay, I got it backwards." (Realizing his error). Teacher: "Are you ahead? By how much?" Student: "$2." Teacher: "Is paying out $4 and receiving $6, is that the same as receiving $6 and paying out $4?" Student: "Yes." Teacher: "What property is that?" Student: "Commutative property."

The model of "receive" and "pay out" was introduced early in the unit and became the reasoning tool Laura encouraged her students to use to make sense of integer situations. This "big" example gave the students a frame of reference that was familiar to them. It provided cohesion and motivation in the unit in much the same way the staff used a big problem to provide cohesion and motivation in the MGMP units. In a second observational segment from the same day we see Laura organizing the examples the students have worked to set up the data to help students see a generalization about situations where you are adding a positive and a negative integer. Yet, at the end of the episode she provides the punch line rather than waiting for student insight.

> You all have answers for numbers 17-24 on your papers." (Teacher writes questions and answers to these last problems on the overhead. Asking for students to respond the answers in unison). Teacher: "How did we get 4 to the question 7 + -3 and get 4?" Student: "We subtracted 3 from 7 to get 4?" Teacher: "How do we get a -9 for -6 + -3. It looks like we added." Then the teacher goes through the questions and the class responds in unison that they either would add or subtract to get the answers.
>
> Teacher says: "Let's look at this carefully." Teacher points out the problems where they added and where they subtracted. Student Comment: "If we have 2 negative numbers we add." Teacher: "Is that true? If we keep going in the hole we keep going in the hole right?" Look at number 10, we got -12. We kept going in the hole. It appears we keep going in the hole. Okay if we have 2 positives we add too. In the other situations we subtracted." Student: "A negative and a positive we subtract."
>
> Teacher: "Okay but there is another problem. How do I know when the answer is - or +?" (Pause). Student: No response. Teacher: "Okay let's do some examples. 5 + -7, 8 + -9, -10 + 13, -12 + 7, -2 + 20. Let's do these in our head

mentally. If we receive 5 and pay out 7 are we in the hole? Yes by 2." Teacher works these problems with the help of a few students in unison. Teacher: "How will I know if the answers are positive or negative. In all cases we subtract." Student: "It depends on if it's going to be positive. If the positive is bigger than the negative." Teacher: "Remember yesterday we said all positive numbers are bigger than a -10. You're on the right track. If you have more positives than you pay out it will be positive. Which of these numbers is farther away from 0? My answer takes on the sign of the side that is farther away from 0." (Then teacher reviews a couple of problems). "We'll come back to that tomorrow."

Another excerpt shows interaction patterns and the teacher leading students to generalization.

Teacher: "Do this one on your first number line: 4-7." (Pause as kids work) "Where did you end up?" Student: "-3." Teacher: "If you got -3 you did it correctly. We started at 4 and went left 7 units to -3. Another way to think of this is what is the difference between 4 and 7. How many units is it? Student: "3 units." Teacher: "3 units in a negative direction. Do this one next: 4 + -7. That's a plus there. We did those (yesterday) remember?" Student: "-3." Teacher: "Does your graph look the same? We start at 4 and because we're adding a -7 we go in the opposite way. They look the same.

Do this one -3 -2. I'm going to put parentheses around mine (-3) - (2). Where did you end up?" Student: "-1." Student: "-5." Teacher: "How many got -5?" Student: Half the hands go up. Teacher: "Where will we start?" Student: "-3." Teacher: "If it said +2 where would we go?" Student: "Right." Teacher: "But since it says -2 we go?" Student: "Left." Teacher: "This means what is the difference between a -3 and 2. How far is it between -3 and 2? How many units?" Student: "5." Teacher: "Now this one (-3) + (-2). What did you get?" Student: "-5." Teacher: "Does you graph look like the other one? Let's do it. We'll start at -3 and add a -2. Which way do we go?" Student: "Left." Teacher: "Look at my graphs. They look identical. Who can draw conclusions about this?" Student: "It's the same problem." Teacher: "What do you mean?"

Later in the same lesson:

Teacher: "Each time I want you to <u>think about</u> the difference. The difference between 4 and 2 is 2 . What's the difference between -4 and 2? How far is it from 2 to -4?" Student: "6." Teacher: "In which direction?" Student: "Left, negative." Teacher: "We'll start at -4 and take 2 from it and get -6." Teacher: "How do we change this to an addition problem?" Student: "Put a + in between." Teacher: "What else?" Student: "Make an opposite." Teacher: "We're going to change it to it's opposite. How do we change this to an addition [(-4) + (-2) = -6] problem? When we pay out 4 and pay out 2 more are we ahead or behind?" Student: "Behind."

At the end of the class period Laura returns to rules.
(1/9/86)

Teacher: "Let me give you some rules so some of you who don't understand this will have something to fall back on." Teacher writes on overhead:

Rules for addition:

1. (+) + (+) = ?
   Teacher: "4 + 3 = 7. So my answer is positive or negative?"
   Student: "Positive."

2. (-) + (-) = ?
   Teacher: "(-4) + (-3) = ? What do I get?"
   Student: "-7." Teacher: "What can we say about the answer, will it be - or +?" Student: "-". Teacher: "Will it always be -?"
   Student: "yes."

3. (-) + (+) -4 + 3 = -1 subtract
   or
   (+) + (-) 4 + -3 = +1
   Teacher: "What is the answer to the 1st one (-4 + 3 = ?)?"
   Student: "-1." Teacher: "To this one (4 + -3 = ?)?"
   Student: "+1." Teacher: "So how do I decide if it's + or -?"
   Student: "Which every one is further away from 0."

It is clear from what she did with the transfer task that she has focused on models and representations of integers -- which certainly is in the spirit of the MGMP model -- but she does not yet see the MGMP instructional model's phases and their importance. The desks are back in rows and students are working individually. The spirit is different in the class. The instructional model used could be described as modeling with controlled practice. She does a good job of this -- but it is not the MGMP model. Since her planning was complete for the unit before our first coaching session I decided to de-emphasize the instructional model and as a coach to focus on trying to help her improve her questioning techniques (which are vital to MGMP instruction). I kept a record of some of her questions during class so that we could explore specific examples and try to come up with better questions. Here are examples of her questions that give away answers,

"We don't need a plus sign, do we?"

"What happened when we tried to take $18 away from $33. Did we go in the hole?"

After a coaching session Laura came back with a lesson that really emphasized students' thinking. She asked better questions and modeled how to think about a problem. Here are some examples.

"How did you do this?" (Procedural)

"Explain how that thinking works on this one."

Let's think about it this way ..."

Student comment: "I got that one. Say this is neat."

Laura comment: "We want to use our heads to make things easier."

Student comment: "I don't know how."

Laura comment: "Study the example and see if you can figure out where the number came from."

In this lesson, Laura modeled metacognitive processes by emphasizing "how you can think about" various concepts. She really focused on each student thinking. When one student was called on and did not know an answer until another student whispered to her, Laura said "You must think for yourself. What is your answer?"

The first round of interviews was conducted with each teacher after she/he finished the first transfer task. These give insight into Laura's thinking at this stage. She is beginning to see that there is an alternative to the approach of teaching the textbook page after page.

> One of the other things that's coming out of this ... And I have to break this mold ... is that we have textbooks, and I kind of abandoned my textbook, and I think that's directly related to my Probability Unit because it was such good material that they wouldn't find in a textbook, and I find that throughout all the book companies I've taken a look at. There's a wealth of excellent material that's not in the textbook. But what I need to do is make sure I refer to this page in the book where they can find ideas related to what I'm talking about. Because a lot of teachers will feel that you shouldn't have to run off all that extra worksheets and those papers when you've got a textbook, but I found some excellent material in the worksheets. And the kids actually prefer it.

Laura was asked directly about why she chose integers for her transfer task,what her goals were, and how this unit differed from her teaching in the past. (L = Laura; I = Interviewer)

L: Because it would give the students something new to work with during first semester. One of the problems I had complained about was that we spent the entire first semester reviewing whole numbers, decimals, introducing even a little bit of fractions, and the kids are not exposed to anything new, which is why we still give the Probability, then I wanted to throw in one more new skill so I chose integers.

I: What was your goal or objective. What did you reach for when you taught that?

L: Something for them to be able to add and subtract integers. That's what they were tested on. And in the process they were exposed to how this related to other things they do in life. But all I wanted to see was skill on the test.

I: Do you have any other comments just in general about the transfer task. You said you're still doing some stuff?

L: We're still doing the coordinate integers now. And it's interesting because I'm pulling everything they've learned over the course of the year... They've learned how to solve equations using whole numbers and decimals. They've been solving some equations. They will be graphing numbers, positives and negatives. Linear equations, I've never done with my graphics, but they will do some like that. Uh ... problem solving ... I've kind of tied it all into something that they've been doing all year long. And they can see how that relates to some of the other stuff ... too.

I: So you're making some linkages between the content and ...

L: We're reviewing the properties that they've learned, reviewing order of operations ... all of that's being reviewed through the integer unit. But when I test them, I just want to know if they can answer that. And that's something I have to learn how to do ... is not try to test everything that I have shown them but just what is the meat of this and what did I expect you to come away with.

I: Yeah. Um huh. Have you ever taught integers before?

L: Uh huh.

I: How is it different from the way you taught it in the past?

L: In the past I would have spent very little time developing integers as a set of numbers. I would have given them the rules for adding and subtracting integers, Day 2 ... They did not get those during that week. Uh...by the end of the week most of the kids were observed as to what they could do. This week most of the kids were observed as to what they could do. This week they got the rules for adding and subtracting integers. Just the way it developed, the way I tried to tie it all together this time...very different. Before they would have had worksheets on adding integers, subtracting them, multiplying and dividing them... boom...test. And I've stretched it out into two weeks and tying everything I can together.

I: Good. Okay...now...is there anything that you would teach the same way...like, like you taught integers last year. What has stayed the same---in your teaching last year. What has stayed the same...in your teaching of integers? Anything?

L: Well they still are getting some practice worksheets, but everything is just done a little bit differently. Maybe I didn't do the number line, develop it as well as I did this year. Or, I've used some of the same tools as I did last year...I just didn't pull it all together.

I: Okay. All right. Right. You used the same materials but used it differently.

L: And some new materials. Very little of the same. So ... I'm looking for different worksheets.

I: What about, now, when you think about your transfer task, what do you see transferring from what you did there to other concepts?

L: I think I would still try to continue to tie as many of the skills that they've learned together as I can. I, I've always felt that mathematics is so segmented You're teaching one skill today, the next skill, and so on, and I'm trying to get them to pull together the knowledge that they've learned and use it, so I'll transfer that...

I: Did you use grouping as much during the transfer?

L: I used grouping once.

I: You said that was problematic. It just hard...

L: Yeah. It's still hard for me to decide when I can use...and if Glenda hadn't suggested that I probably wouldn't have done it then...Uh...that's something that I probably wouldn't have done it then...Uh...that's something that I'm going to work on. I am beginning to launch activities a little bit differently. I am trying to hook kids into a concept before I try to teach it. Whereas in the past I might say: Okay. Today we're going to learn to do this...and bam...here it is. Here's how you do it. Now I'm trying to get their interest level up first by finding a different way to launch an activity...and then give

A little later in the interview Laura critiqued herself on the launch-explore-summary model.

> When I think about the launch-explore-summary model, I think I spend too much time on the launch...if the launch is what I perceive it to be when I am trying to get the students ready to be able to do an activity, and with me, I guess it's still part of my nature to, to teach the subject and explain it to the best of my ability and maybe get them to do activities along with me at the same time... and then give them their worksheets to do to be completed at home.

Laura rated teaching the Probability Unit, the planning sessions with her coach and the feedback as extremely helpful with the transfer task. She saw the other aspects of the Summer Experience as somewhat helpful. On reflection Laura seems to sense that aspects of her transfer task did not reflect the MGMP model very directly. She indicates in the interview that more direct help from the coach would have been useful.

I: What do you want Glenda to do differently?

L: I can't think of anything I'd want her to do differently. I value her...

I: Do you want her to be more critical, more supportive...

L: No don't be more critical...laughs...No. She's found a happy median in me. She knows how to pat me on the back and tell me, okay Laura, you did this and that's okay." I can handle that. I can't take what we did to the staff this summer. No. I'm getting a great amount of help. Can't say I want anything done differently. Maybe. If anything something got screwed up in time as far as getting me straight on my transfer task, I would probably need a little bit more supervision in developing my transfer task to make sure that I am using the model that you want. Because I kept saying is this what you want? Uh...to have it looked over and say, yeah, this would work out fine. And I think Glenda did that, but I still don't feel sure I did that... Just a little more guidance developing the task.

The Similarity Unit and the Second Transfer Task

In late January Laura started the second cycle of MGMP unit and transfer task. With the

Similarity Unit I felt the time was right to begin to emphasize the instructional model in our coaching sessions. I organized my written comments to Laura with Launch, Explore and Summarize headings. This allowed us to use the language and to continually focus on the meaning of each part of the model. I had two additional goals to lay over the phases of the model. We continued to work on questioning. As a coach I frequently wrote down a suggested alternative to her questions which we would consider during our coaching sessions. I also emphasized the importance of keeping the mathematics front and center in the students' minds to avoid the problem of activity for activity's sake. One continuing problem which I did not tackle was Laura's inconsistency in the class. She continued to be emotionally up and down. On down days she would say "I'm tired and you have to listen carefully." On these days her signals were confusing to the students. "Is this mathematics important or isn't it?" would surely be a question in the students' minds. Laura continued to make judgemental comments which can give students excuses not to learn.

"This is hard."

"This isn't going to go well today is it? Maybe you'll catch on."

"This may help some of you. Some of you will choose to do it mentally."

"We will get through this?"

Over the teaching of Similarity Laura ran into several spots where she was fuzzy on the mathematics. By this time the students threw out so many conjectures, that at times Laura could not judge the correctness of their suggestions. The students had come a long way in their thinking, guessing and conjecturing. Laura needed to have real insight into the math in order to guide their thinking. At times she had to put them on hold, because she did not know if they were correct or not. Some of our coaching time was devoted to sorting out what the students were saying.

In one example, a group put forward a conjecture during the summary that connected the group of triangles similar to the 3, 4, 5 right triangle through an additive pattern rather than a multiplicative pattern. Laura put them on hold. That group refused to leave at the end of the period until Laura and I had helped them see that in fact their conjecture works only with that one family of similar triangles and not with similar triangles in general. The fact that the conjecture work depended on the fact that the sum

of the edges was equal to the product of the legs.

$$(3 + 4 + 5) = (3 \times 4).$$

The students were extremely pleased with themselves even though they realized that their rule was virtually useless. They had done some good thinking. Laura emphasized in our coaching session that had I not been there, she would not have been able to figure out what was going on. One coaching role that I have played is that of content expert. Laura seems to be quite open in saying "I don't understand this part."

The field notes from three activities in the Similarity unit show improvements and areas of needed improvement. Laura is making progress in questioning and in allowing students to contribute to the development of ideas. Here is a segment that shows how easily the students handle the (x,y); (2x,2y); (3x,3y); (3x,y); and (x,3y) notation.

> Let's go back to Morris II. He doesn't have any coordinates. It says 2x and 2y. What does that mean?" Student: "We'll times them by 2." Teacher: "So for point A we'll have what? Student: (Correct responses.) (Teacher does examples on overhead). Teacher: "And for point B we'll have what? Student: (Correct response.) Teacher: "Yes you times it by 2. Here you go 2 x 7 and 2 x 2. (Teacher puts this on graph). Let's look at Morris III. What are it's coordinates?" Student: "Times by 3." Teacher: "What will we have for the first one?" Student: "15, 0." Teacher: "For the next coordinate?" Student: "21, 6." Teacher: "Be real careful because you have to multiply carefully. What about point 3?" Student: "21, 21." Teacher: "Okay how about Boris? The coordinates for Boris are 3x and y. What does that mean?" Student: "Keep y the same." Teacher: "Yes and how about x?" Student: "Multiply by 3." Teacher: "Right so what do we get for Boris?" Student: "21, 2." Teacher: "Okay for point C. What do we get for Boris?" Student: "21, 7." Teacher: "Let's look at Doris. What happens to her?" Student: "x is the same and multiply the y by 3."
>
> Teacher does 2 examples and says: "You get the idea of how to do it now? (Pause). Two in your group will do Morris 2 and Boris and 2 will do Morris 3 and Doris. You decide who will do what in your group and do it."

Another segment shows the teacher asking more thoughtful questions.

> Teacher: "How would you go about telling somebody how he grew?" Student: "His mouth is 3 times bigger." Teacher: "Look at his nose. How did his nose grow? Look at the width. Did it grow 2 times as much? Look at the side of his mouth?" Student: "It's grown twice as much."
>
> Teacher: "Do they look like they belong to the same family?" Teacher to student: "What's the same about them?" Student: "They look the same." Teacher: "How are they

different?" Student: "It's bigger." Teacher: Let's pin point it's mouth." Student: "It grew 2 units."

Teacher: "How about the perimeter of his nose?" Student: "4 times bigger." Teacher: "Is the perimeter of yours 4 times bigger?" Student: "5 times." (Wrong). Teacher: "How'd you get that?" Student: "Oh, I count the squares." Teacher: "No that is the area. You count these sides. What's that? Here you have what?" Student: "6." Teacher: "And here?" Student: "12." Teacher: "So how much bigger is the perimeter?" Student: "2 times."

One problem became obvious during this unit, Laura's use of grouping was superficial. Students are put into groups because the script calls for this arrangement. However, by her actions Laura does not in any way hold the group responsible for anything. The students have no clear expectation about what they are to do together. They can continue to work individually even though their chairs may be close together. At the same time Laura began to see her role in the Explore phasee as something in addition to monitoring behavior and progress. She began to ask questions to stretch the students' thinking. "How do you know they are similar?" Why are we looking at ratio?" "What does your information tell you?" "Why aren't all rectangles similar?"

This problem with group work and the role of the teacher during group work was one that many of the teachers in the project experienced. This was such a radical change from the role of teacher as "deliverer of knowledge" that it was not surprising it was a difficult change. Giving up the tight control that "eyes front" allows requires the teacher coming to trust that students can assume some control without chaos breaking out. With Laura the change began through observing me during the Explore phase as I modeled how to ask questions to keep students focused and to extend their thinking. She would frequently come near a group I was working with and listen. I would then see her asking similar questions to other groups. Another way that a coach can help is through being able to focus on and record student to student interactions so that during the coaching sessions we could talk about particular student insights and confusions. This technique of putting us together as we examined student reactions to the mathematical tasks posed was a powerful technique for causing Laura to reexamine her expectations and beliefs about students. Through these kinds of interactions she began to watch and listen to her students in a different way. She began to realize that a group of students could mention "the game" on Friday night barely missing a beat on pursuing the mathematical goal. Her estimate of

time on task during group work went up.

During the interview at the end of the year Laura makes some comments that show her progress on grouping but that also show that she still has a way to go before this becomes a teaching technique that she would use habitually. (L = Laura, I = Interviewer).

> I: Okay, what kind of, when you think about the similarity unit, what kinds of changes did you have to make in your usual teaching style.
>
> L: I was going to ask a question for this summer, to ask a set of questions for next year (laugh). When does my teaching style become mine and when is it still borrowed from MGMP? You know. A lot of the things I've incorporated into my way I do things.
>
> I: Yeah. L: So, even after we did the probability unit, we did some group work and we did work with manipulatives then I did my transfer unit and we did some group work in that.
>
> L: I learned a lot of this year watching my kids work in groups and being around not just laying back and saying, what are you talking about over there? The kids are on task a lot more than I think they are and they are talking mathematics, they are getting help and I see them working together in ways that I haven't allowed them in the past you know. The minute a kid spoke and they weren't supposed, they weren't speaking to you it's like what are you doing, what are you saying. These kids are learning a lot from each other. That's how they got through their whole review this week.
>
> I: In groups?
>
> L: I had them working together. Talk to your neighbor, use your book, and they were really working on it.

In the interview Laura was asked what the students got out of the Similarity unit. She responded:

> They had a concrete way of finding area. And it was the first experience we had with counting squares counting these for perimeter. Um ... those were first concrete experiences. Then when we went to area later on, they were able to define and develop area quicker.
>
> I think they enjoyed going through the activities but I think they missed a lot of what I was trying to teach them.
>
> Because when it comes time for them to do problems based on what we may have just talked about and summarizing the activities it's just how do you do this.

This excerpt shows that she is beginning to value students having a concrete way to make sense of ideas. She is still, however, wrestling with students perception of math as "how to". They clamor for

a rule and Laura often gives one. Her own need to "tell" math at times causes her to rush the summaries by giving the rule or result that the students are on the verge of discovering.

In the observer's high inference summary at the end of the Similarity unit, she confirmed this tendency. She said,

> "The summary is the weakest phase. Since groups are not used optimally, student spokespersons speak only for themselves. Students seem bored or lost during this phase as a result. The teacher's need to control is most evident in this phase as she controls the questioning and beats the students to the statement of the discovery."

The observer's summary also noted the improvement of the teacher during the Explore.

> "The teacher is good at monitoring. There are no invisible students or students with whom she spends too much time. She is quite good at facilitating. She asks questions to initiate student's thinking. "What is the same/different about the cats?" "How are they growing?") She also shows interest and offers encouragement."

Over the course of the unit Laura became more able to think about the model. This was reflected in her preparation for the second Transfer Task. While she still had students working individually at times, she specifically asked for help in planning the explores so that students would have a chance for group work. She set her goals as developing an understanding of the meaning of percent. She used some activity pages from the Mathematics Resource Project. In addition, she wrote a very nice letter to parents to get them involved in discussing percents found in the real-world with their children.

The Transfer Task was moderately successful. Pacing was a problem. The unit was not polished. The phases of the model not carefully conceived to avoid some problems occurring with students understanding what they were expected to do. There was, however, the nucleus of an excellent unit in this first attempt.

Laura was asked about the transfer task in the interview. Her goal was for the students to be able to calculate percents mentally and to estimate reasonable answers and to solve percent problems. She used models to help with calculations and problems.

> "And the old me wanted to jump in there and say hey let's do a proportion. ... and at the last minute we did proportions and that confused kids at lot."

Over the year Laura began to realize that using models to help build concepts did not automatically improve paper skills.

"One thing that I have found is that kids can tell me verbally but they can't necessarily do it on paper. I went through a child's test who got many of the percent problems wrong because she forgot it was out of 100. And she could answer all those questions very quickly verbally."

Summarize of First Year

In the interview at the end of the year, Laura shows where she was in her thinking about the MGMP experience. (L = Laura; I = Interviewer)

L: Well what I need to do, now see, it's just like anything else that I do, these units are so nice and neat and wrapped up real tight, once I teach that unit I don't necessarily go back to it and draw from their experiences throughout the year.

I: Yeah.

L: So I'm still treating this as an isolated unit. I need to, maybe I could do it this summer, maybe confirm the plans in my brain. I'll see where everything else connects with what we're doing in our classroom.

I: Huh, huh. Yeah, that linkage is something I think that comes after you've taught it once and then you start thinking about now.

L: Oh, I could have done that.

I: Sure, sure this goes back to fractions or this goes back to that and that. Yeah. Okay. Um ... now what do you think about the way you taught the units has transferred to your teaching of say, decimals.

L: I probably am not your typical participant. Because I don't know if you remember me in the summer I was so intent. Everything I was counting on, damn why didn't somebody to this with me a long time ago.

I: (Laugh)

L: I was ready for something different. I knew I was working on concepts but I was still having the pressure of working with kids, increasing their test scores and I knew there had to be a better way of getting this information across. I wanted to take some classes, then I had th summer workshop.

I: Huh, huh.

L: So I'm kind of taking it, I'm taking in as much as I can probably process at one time and I've tried to implement as much of what I have learned as I possible can, to the point where I did on my own the fraction unit and trying to use the model. It's still in the experimental stage but out of that I learned a lot about what I'm trying to teach the kids and how I might use models to do that. Initially when I look back what I had taken in what I thought I was learning, what I thought I was doing, I still hadn't understood the model.

I: Huh, huh.

L: the launch, explore and summary. I pulled together some more dittos, these dittos covered this. So I think now though it's finally becoming part of me to

> the point where even when I, when I taught circumference um ... doing area performance I had my student teacher and we worked out a unit that was more conceptually based than something skill oriented. And the kids actually experienced cutting apart the different shapes and seeing how we developed those formulas and it made an impact on the kids. A lot of what I've done this year it just blows my mind the way kids take a test. Now when they want to find area they're drawing squares on their paper. They have something physical, something that they can take with them you know, as opposed to just a formula. Unfortunately they tried to do that with a trapezoid but they had a pretty good idea (laugh).

The teachers repeated the Teacher Inventory and gave the Student Questionnaire at the end of the school year. We calculated a level for each teacher by computing how far from the "ideal" answer each teacher fell. We did a similar computation on student responses. Laura showed a considerable move toward the "ideal" in her responses. She was able to think and talk about conceptual understanding. However, her students did not perceive a change as reflected in the student inventory. There was little change over the first year in how students saw Laura teaching and organizing her classroom.

As the year ended I saw Laura as a teacher whose ability to think and talk about conceptual understanding was ahead of her ability to create a classroom environment that was consistently conceptual in focus. She taught some brilliant lessons during the year. But also had periods when she was very much the deliverer of knowledge for the students to soak up.

Toward the end of April she was really beginning to worry about how her classes would perform on the district monitoring exam which was computational in nature. At our May all group planning session she was very verbal about her concern that this new direction (conceptual focus) must be successful in the computation development or she and other teachers could not continue.

When the district scores came back and her classes performed extremely well she became a zealous believer. During the summer workshop she spent each afternoon after the workshop with a colleague making a year's plan for their curriculum that incorporated parts of all 5 MGMP units. She was very creative in reflecting on the year and organizing the district goals around the units. She showed that she was perceptive at seeing how she could make connections between the prescribed district objectives in mathematics and the MGMP units.

Year 2: The First Cycle, Similarity and Fractions

During the second year of the project Laura chose to teach the Similarity unit in November and

the Fractions Transfer Task in December. This was part of the 7th grade year's plan which she worked out with a fellow teacher. As is described in another part of this report, the teachers worked on the Fractions Transfer Task in groups during the summer workshop. Each was free to choose any part of the total work done on fractions to include in their own Transfer Task. Laura elected to start her year with another MGMP unit, Factors and Multiples, and to include a fourth unit, the Mouse and Elephant, after Christmas. Her year consequently had 6 focal points, the four MGMP Units and her two transfer tasks, Fractions and Percents.

During the summer workshop, Laura took notes, especially focusing on questions that the two staff members who were teaching added to the script. She also came with her mathematics questions and seemed determined to get it all sorted out so that she was confident that she knew what the big ideas were and understood them in a way that allowed her to think about teaching students.

This increase in confidence and mathematical understanding was apparent from the first observation in November. Because Laura had a better understanding of where she was going she was able to give the students a better organizer. Comments like the following were often used to focus student exploration.

> "That is what I want to pay attention to. We are going to look at the area of the figure. I want you to pay attention to what is changing and what is not."

Another immediately obvious change is that Laura has a question or two on the overhead every day when the students enter. They sit down and work these out as she takes role. These openers ranged from review on some days to an advanced organizer for class that day. Here is an example from the overhead of each kind.

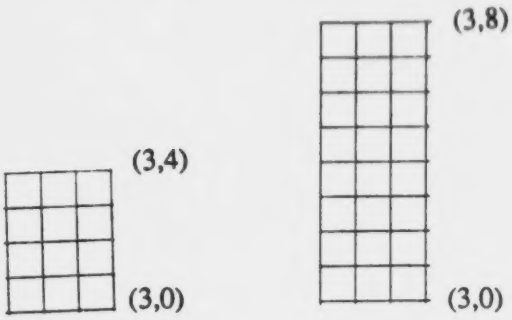
> Solve each problem. Record answers in your notebook.
>
> List all factors of each number.
> (1) 10 (2) 35 (3) 17 (4) 30
>
> Write prime or composite.
> (5) 43 (6) 59 (7) 19 (8) 51

Write the prime factorization of each.

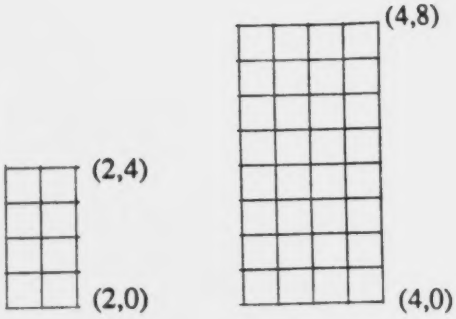
(9) 54 (10) 30

Guess my rule: How did they grow?

(1)



(2)



(x,y) ⟶ ?

(x, 2y)
(2x, 6y)
(2x, 3y)
(2x, 2y)
(2x, y)

(x,y) ⟶ ?

(x, 2y)
(2x, 2y)
(4x, 2y)
(4x, 2y)
(2x, 4y)

As soon as the class has correct answers for these, she uncovers the other part of the transparency on which she has asked the additional problem: "Describe several rectangles that are similar to the given rectangle."

Another difference in Laura's teaching is illustrated in the questioning excerpt from November 12, 1986. Note that students are providing more of the answers and Laura is asking follow up questions to get a more complete answer from the students. Last year she would have simply embellished the students' answer herself.

T: "What things remain the same when we go from Morris 1 to the others Morris 2, 3?" S: "The nose?" T: "How are the noses the same?" S: "Rectangles." T: "How about the mouths?" S: "The same." T: "What do you mean?" S: "The same shape." S2: "The eyes?" T: "What do you mean?" S: "Dots." T: "What else?" S: "Ears." T: "What about the shape of the ears? Is the distance between the 2 sides of the ears the same? (She is putting one picture on the other of the transparencies trying to show they have the same angles) 8:30 T: "What do we call these?" S: "Angles." T: "We are looking at the angles of the ears. What other things seem to remain the same?" S: "The chin." T: "How?" S: "Flat." T: "What other things?" S: "They all have the same lines at the bottom. (Using the transparency the teacher compares between the angles of Morris 1, 2, 3. She puts one picture on the other and checks the angles of the mouth,

chin, etc)

T: "It appears that all the angles remain the same. Look at Boris and Doris. Do they look similar to our Morris?" S: "No. Doris tall and Boris is short. T: "What else is different?" S: "Her face is too skinny." S2: "The ears." 8:33 T: "Let's talk about the ears. How about the angles? Are Doris' angles in the ears the same as Morris' angles?" S: "No."

8:35 T: "Morris 1 and Morris 2 - do the noses have the same shape?" S: "Yes." T: "Boris and Doris - do they have the same shape as Morris' nose?" S: "No." T: "What are they?" S: "Rectangles." T: "Are they similar?" T: "Is it enough to compare the angles in order to decide if they are similar? The angles are the same. So we need something else to decide. (She shows on the transparency that the angles of the rectangles and the square are the same.)"

8:38 T: "Look at your summary sheet." S: "How about Joris?" T: "Let's look at Joris. Did Joris grow?" S: "Yes." T: "What happened to Joris? Did Joris become bigger?" 8:39 S: "Joris looks like Morris. The noses are the same - 2 squares." S2: "I think that because of the squares on the sheets you gave us are bigger this is the reason for the impression that Joris seems bigger." (She gave them 2 different grids. One of them had smaller units than the other and this is what the student trys to explain.)

Laura was much more confident in her understanding of the Similarity unit this year. One interesting and problematic result of this was that at times she tended to overkill on the Launch phase. At times she asked so many questions and added so much to the launch that there was little if anything left to explore. She seemed determined for every student to understand. In spite of these occasional pacing problems, the students seemed genuinely engaged in the mathematics throughout the unit.

The transfer task on fractions used folding strips as the model to help students understand the meaning of fraction and to develop the concept of equivalence. Laura had not ever used manipulatives in teaching fractions before this unit. There were times when she threw too many concepts at the students at once, but overall the unit was quite effective. The students were very task oriented, enjoyed the activities and were able to model fractions and use these models in answering questions involving fractions. Two excerpts from the observations show her questioning and student responses. Note the unnecessary inclusion of combined inequalities $1/2 > 1/3 > 1/4$.

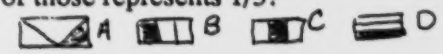
8:32 T: "When we are talking about fractions we have to know what a whole is. This is going to be our whole. (The teacher holds a green strip of paper.) This is the size of the whole. Write 1 on it. (She does it)"

8:35 T: "Compare the green one to the yellow one that you have." S: "They have the same length." S2: "They have the same width."

S3: "They have different colors." T: "What do we call them if they have the same shape?" S?: "They are congruent."

T: "Fold the strip into two parts. (The teacher folds her strip into 2 unequal parts. Most of the students folded theirs into 2 halves) Did anyone fold it into half? (The students show her what they did. Everybody has 2 halves, she doesn't) Can you tell me what to do so that I will have half too?" S: "They have to be equal." 8:38 S: "Fold it in the middle." T: "Compare your half with your neighbor." (writing on the transparency) T: "On each of your equal sides write 1/2. (She draws the picture of a strip divided into 2 halves and write one half on each part of it) S: "Whatever makes you happy."

T: "How many halves does it take to make a whole?" S: "2."
T: "What name do we call the top? (No answer) T: "Numerator."
8:40 T: "What is the bottom part?" S: "Denominator." (The teacher writes 1/2 on the transparency and writes numerator for 1 and denominator for 2)
8:42 T: "What does my denominator tell me?" S: "Divide into 2 parts."
T: "Can you be more specific?" S: "2 equal parts."

T: How can I fold this bar into thirds? (She folds her bar into 3 unequal parts)
T: "Do I have thirds?" S: Sort of. They are not the same size." 8:45 T: "Can you explain to me how to fold in into thirds?" (A student tries to do it. A student explained that she folded it first one side and then she folded another side until she had 3 equal sides, 3 equal parts and then she pressed) T: "Why don't you try it and see if you get equal parts. Since all the strips were equal when were started, check, if your one third is equal to your neighbors. The part in the middle will be what of our whole strip?" S: "1, 1/3." 8:50 T: "Which of those represents 1/3?" (She shows a transparency of 4 figures) 

T: "Your job now is to carefully fold your remaining bars into (She says and writes) 4ths, 5ths, 6ths, 8ths, 9ths, 10ths, 12ths. Then she adds:) If you finish fold into 7ths, 11ths, and whatever you want to (She adds the 7ths and 11ths to the list. She writes and says:) T: "Label each part. Compare one of your pieces for 6ths and 9ths to your neighbor.

(The children work and the teacher walks around helping them) 8:53 S: "I got 9ths. " T: "What will you do with that?" (She means some leftover of the strip)
S: "Cut it off." T: "No you cannot. You will change the whole." 8:55 (Phone call for the teacher) S: "I got 1/8 this time and this time it is right.." S: "I got 13ths"
T: "Do first what I asked you to." S: "I did not mean to." T: "Oh, it was an accident. Don't fold your bars in this way. (Some students folded their bars along the long side instead of the short side)

The following day

T: "Will 7/8 be equal, less or greater than the whole?" (The teacher writes 7/8 less than 1 and uses the less than symbol for that).

8:32 T: "A unit fraction is one of the pieces that my bar is divided into. 1/3, 1/4. Compare the size of the unit fractions. Make some observations." 8:33 S: "Can you compare any of them? 1/4 and 1/8. 1/8 is 1/4 folded in half." T: "In terms of less, greater or equal to what would you say?" S: "1/4 is less than 1/8."
(The teacher is writing on the transparency, 1/4 > 1/8. She uses words and the greater than sign.)

8:35 T: "Think of other unit fractions." S: "1/2 and 1/3." T: "How do these sizes compare?" T: "Write a comparison statement about 1/2 being greater than 1/3. 1/2 is grater than 1/3." (She's writing 1/2, she leaves a space and 1/3.) T: "Again we write 1/2 > 1/3." (She uses the greater than sign)

8:37 T: "Why don't you compare with me 1/6 and 1/8. Compare for me 1/12 and 1/9." S: "1/9 > 1/12." T: "On your paper write 1/12 first and then 1/9. Which symbol are you going to use? Less than or greater than?" S: "Greater than." 8:40 S: "1/9 > 1/12." T: "What symbol should I use?" S: "Greater than." T: "Like this. (She writes: 1/12 > 1/9.) Read it." S: "1/12 > 1/9. It has to be less than."

T "1/13 and 1/15, which one is greater." S: "The pieces for 1/13 will be bigger."

T: "Would you agree with me that 1/2 > 1/3 and 1/3 > 1/4?" S: "Yes." T: "1/2 > 1/3 is true. Is 1/3 > 1/4 true?" S: "Yes." T: "We have 2 true statements. I want to combine them. These are combined inequalities." (The teacher writes 1/2 > 1/3 and 1/3 > 1/4. In a new line she writes 1/2 > 1/3 > 1/4.) 8:43 T: "How can I do that using less symbols?" S: "1/4 < 1/3 < 1/2." T: "Both statements have to be true before I can combine them.

Work in groups of 2. One has to fold the bar so 2/8 is shown. The other fold so 3/8 is shown. Which one is greater?" S: "3/8." T: "What symbol should I use?" S: "Greater than." 8:46 T: "So 2/8 > 3/8." (She writes it on the transparency) T: "We read it from left to right.

8:48 T: "I want to find another fraction that is equal to 1/2. Another piece that is equal to one half. Prove to me that it is equal." (The teacher tells the students that they are going to talk about equivalent fractions.) S: "1/4 = 1/2." (The teacher writes 1/2 = 1/4.) S: "Oh, 2/4." (The teacher writes 1/2 = 2/4.) T: "Natasha, did you find another fraction that is equal to 1/2?" S: "1/8." T: "Fold your bar and show me 1/8. Angela, what do you think?" S: "6/12." (The teacher writes 1/2 = 6/12." 8:50 T: "Gabrielle, I want you to show us 1/2. I want you to show us how you fold the 8ths bar." S: "Oh, 4/8." S2: "3/6." S3: "5/10." (The teacher writes 1/2 = 3/6 and 1/2 = 5/10.)

8:53 T: "Let's find a fraction that is equivalent to 3/4. What do you have to fold first?" S: "3/4." S2: "6/8." S3: "5/7." T: "Everybody take your 3/4 and 5/7. Compare these 2." S: "5/7 is too small." 8:55 T: "How does your 3/4 compare to your 5/7?" S: "5/7 is smaller than 3/4." T: "Who has a 7ths bar? Let me look at that. Here is 3/4 and I am going to compare these 2." S: "The 5/7 is smaller than 3/4." (The teacher writes 3/4 > 5/7) T: "Find me another one that is equivalent to 3/4." 8:57 (The teacher distributors worksheets of activity 1-3 which is numbered 1 by me.) S: "9/12." (The teacher writes 3/4 = 9/12.) T: "Everyone compare these 2. Compare 3/4 and 9/12." (The teacher shows the student how to fold the bars and compare them.)

The Probability Unit and Second Transfer Task

During the fall Laura coached another teacher in her building. The teacher visited Laura's class to observe both the Factors and Multiples and the Similarity Unit. Then Laura observed the teacher

teaching and had coaching sessions with her. In addition Laura had a student teacher part time during the fall. This changing role from teacher to coach also added another dimension to our relationship. Now, I was coaching a coach. Part of our discussion always focused on problems she observed and wanted to help her teacher change. This experience of coaching someone else was a powerful intervention in Laura's progress. It helped to focus her attention on the mathematics, on students' understanding, and it damped down the theatrics and smoothed out the personality swings. The responsibility to model the unit for another teacher caused her to put the mathematics front and center and herself in the background. This was markedly obvious in the Probability unit. Both years she did a good job. However, in year two the students were given more opportunity to discuss and explain. The activities were successful on their own mathematical appeal to the students. She did not overwhelm the mathematics with her own dramatic flair. Her class was a calmer, gentler place for students. The down days were not so down and the up days were not so exhausting.

An excerpt from the observation of Activity 6 shows the students engaged in a good discussion. They used complete sentences to try to explain their ideas.

> (She tells the students a story about how she was listening to the radio this morning, 95 FM and there was some car to be given away)
> T: "I have 2 hats and 4 marbles. If I reach a hat and pull out a white marble I win. What arrangement should my friend have the marbles so I have the better chance to win the car." (She wins the car if she pulls out the white marble. The teacher draws a picture of 2 hats and writes RR WW for the marbles and then she asks the students to give her suggestions how to arrange the marbles in the hat so she has a better chance to win. They suggest the following 5 suggestions.
>
> 11:20 T: "Do you have a better suggestion? Is there another arrangement? If I reach this hat. (She points to hat 2 in arrangement E) Should I get the car?" S: "No." T: "So this hat is still part of it. Which one is better?" S: "B." T: "Can you explain it?" 11:23 T: "Does anyone want to support another suggestion? S: "C." T: "Can you explain it?" S: "Chances to get a white is 2 to 3." S2: "A, 50:50 chance." (The students give a good argument in choosing one possibility over another. They don't just give the letter of the possibility but really try to explain why they chose it)
>
> T: "Have you heard enough?" S: "Yes." T: "Everybody has a choice in your head. Heads down, eyes closed. Raise your hand if you choose A. (3 students raise their hands. They cannot see each other since their heads are down and their eyes are closed) Raise your hand if you choose B. (12 students) Raise your hand if you choose E. (0, nobody raised his or her hand)

The observations this year show none of the negative comments that were in evidence the first year. Laura is much more secure in giving more time for ideas to evolve. She is better organized since she knows better what to expect in each activity. The rush to task completion that frequently resulted in Laura giving rules or procedures for getting answers was almost never in evidence the second year. She has a conceptual focus consistently in her classes.

The Final Interview

In the final interview Laura is asked to reflect on her students. (L = Laura, I = Interviewer)

I: Ok. Of these which ones are still giving your students problems?

L: Memory. I don't ask them to memorize a whole lot of information but memory is still an important part of what they have to recall when it comes to taking a test, just being able to communicate with me. Their skills are still shaky as far as being able to compute. Their conceptual understanding is much better. I feel really good about their basic understanding of concepts. Problem solving skills have improved but always need some work on. But I'm pleased with their abilities in solving problems. I didn't spend time this year in saying, "step 1 read the problem, step 2 do this, step 3," because you've seen those checklists and all the problem solving that we've been is kind of like, let's get in here and take this problem apart any way we can and try and solve it, and that's how my kids kind of slug it out, and when I gave them the Shaw-Hiehle computational test, that portion of the test I can remember very clearly in the past - kids will skip it. They might do one or two problems and say, "hey, I can't understand any of this." Now they will go through all of these and they are actually trying to find some way to solve that problem, and I think part of what I need to put more focus on with my kids is making a better connection between their models and actual algorithmic processes. I went through the model and I wanted it to kind of unfold all this information to them, and I think I still need to focus after we've gone through that, "Ok, now this is how we can do it", and use the rules. I didn't do a lot of that. Generalizations are getting real good.

I: What do you attribute that to?

L: I attribute that primarily to the MGMP units. By doing four of them it' has been so ingrained within the unit that they're looking for ways which they can summarize and draw conclusions.

I: Ok. What motivates your students to learn content?

L: Their interest has increased because we use the manipulatives. They really enjoy that. Many of my students have expressed that this is the first year that they've really had a chance to visualize a mathematical problem and then talk about what they're saying, and be able to explain - that really kind of helped them. And I've seen the motivation increase in all of my kids because the minute something is in their hands they want to manipulate it and solve problems with it. And they weren't off task all the time. Sometimes they played with it, a lot of the times when I wanted to get them moving on a particular activity they were right there and they were interested in doing it. So I think the material

that was presented to them captured their interest and that motivated them to do it.

She was asked if the MGMP units had affected her usual teaching style.

> L: I have changed significantly if my teaching style. Just allowing the kids to work in groups and getting all the kids engaged in thinking about mathematics and expressing their opinions. I think the biggest change for me was to use some type of manipulative to get kids to organize data. The MGMP units gave me a compact or concise way of presenting problems to kids. I'm out of my seat more throughout the hour. I don't have time to check papers during the day, and in the past I could find time to get some of my work done and get up and help a kid now and then.
>
> I: Do you find that in general your classes are less teacher directed, that you relinquish more ownership for the students learning?
>
> L: I give up a lot. The students are really good at helping each other and they can explain things more clearly sometimes than I can, and I've been thinking about why. Since the beginning of the school year they've been working on conceptualization and understanding concepts using a concrete model and this is kind of like my first year in using a concrete model, and even though I've presented it to them and I think I've done a good job of it, I still think on an algorithmic level, so the kids explain things very concretely and when I want to take the long way around the problem because that's the only way I can see real clear.

Laura has begun to see the fragmentation of usual instructional materials and seems committed to reorganizing her curriculum in chunks.

> I: Ok. What about the way that you taught the units that you think has transferred to your teaching of your other content?
>
> L: Well it has transferred - getting kids to organize data, to collect data, to look at a chart and generalize from the data that has been collected. I use manipulatives in other areas. I'm beginning to put my other areas that I teach together in a much more organized way instead of just pulling out a worksheet because I think this is good, and still right now it's a collection of good worksheets and from that collection of good worksheets I'm gonna work on that when I find the time and put them together so that they're not doing as much as I gave them. I gave them a lot of worksheets and I think I can pull out the ones - maybe consolidate them is the word that I'm looking for.
>
> I: Ok. Now if Glenda said that you were going to have to teach another Transfer Task next year on decimals what's the first thing that would come to your mind if you knew that you were going to plan a Transfer Task for decimals?
>
> L: What model am I going to teach to develop the concept. I'd probably use the base 10 blocks. I wouldn't even have to think about it because I know that's what I'd use. My next question would be - I've already done work on decimals so I'd have to go through the material I already have compiled and fine tune it and reorganize it so it becomes meaningful. I'm going to try and integrate decimals and fractions next year so that's what I'm trying to give some thought to. I'm trying to think more about equivalent fractions, much more than I did this year and see if I can make those connections a little bit better throughout the end of the year.

I: So if you put like fractions and decimals and ...

L: I'm going to try and make the fractions, decimals and percents connection a lot earlier in the year and work on the equivalent notion and then later on go back and talk about what is a percent. So I'm going to stick with that for a while.

Laura was asked about working with other teachers in the building.

I: Alright, as you worked with other teachers in the building and student teachers has it affected the way in which you worked with them?

L: Yes. As far as the way I observed my student teachers I observed them the way in which Glenda observed me - we all talk about mathematics now all the time - the professionalism - that level has been raised significantly and people just wonder what's going on in this building because that's all we talk about is ways in which we're gonna teach kids, and that excites me because prior to that we didn't do a whole lot of talking about instructional strategies - we did a lot of talking about, "oh, that child did this, I can't stand that child," you know, that type of thing, and that's been improved significantly. My student teachers and Kate's student teacher, they talk to other student teachers, we talked about what we were doing, and I'm sure they were excited whether they will admit it or not. It was a lot of work for them but I think they will appreciate it - I think they truly will, and Lori, in particular, my student teacher, there was another student teacher in the building who wasn't involved with me, she showed him how to teach decimal concepts using manipulatives, he probably didn't even do it, but she did take the time and go through modeling some of that for him. In my building there are other staff members, special education staff members have come to me and asked me to demonstrate how to teach fractions.

Summary

The case constructed from the project data shows that Laura Ride is a very different teacher after two years of intervention. She has a different set of expectations for her students. She believes that they are capable of making sense of mathematics and that ideas are more empowering to her students than computational skills alone. However, she still is searching for a satisfactory balance between teaching concepts and procedures. The system wide grade level monitoring exam is basically computational. She has established herself as a leader in the district and consequently remains concerned that her students' performance on this exam does not drop. She feels that her credibility would also drop if this were the case. Thus we see a teacher with a strong conceptual orientation who looks for ways to make sure that her students maintain computational sharpness. The tension between her beliefs and the reality constraints is still a problem for her.

Over the two years Laura's focus in the classroom has shifted from using her dramatics ability to hold the students to putting the mathematics front and center. In teaching the units the second year Laura

was much less a factor in students' engagement in the activities. She managed to be much more low key and to keep the students focused on the mathematics underlying the activity. The results of this focus showed up in a very good performance by her students on the unit tests given pre- and post. Figure ___ shows Box and Whiskers Plots for her classes on Similarity in 85-86 and in 86-87. The 1986-87 classes showed better results than comparable classes in 85-86. Both years her students had greater gains than comparable classes in the large evaluation study of the units conducted in 1984.

Beginning during the second year of the study and expanding during this year, Laura has assumed a leadership role in her building, her district, and within the state. She has established an active role in inservice and coaching of her peers. This year she has an extra planning period which she has used to work one-on-one in an intensive coaching role with each sixth grade teacher in her building. She wrote a proposal and received the equivalent of 12 days over the year for inservice work with her staff and within the district. She received a state grant to purchase manipulatives. I worked with her on the early workshops, but now she has established her credibility and is in increasing demand to do inservice work with other districts. She has given presentations at area conferences, the state conference and has traveled to neighboring states to do presentations on the MGMP materials. All of these public professional activities have caused her to continue to reflect, to evaluate, and to grow. She has attended a once a week Math Education Seminar on campus all year to continue the contacts and stimulation. In one of the seminars a staff member gave a talk on the MGMP research project. A member of the audience asked if we felt the intensity of coaching could be reduced without decreasing the progress of the teachers. From the audience Laura immediately answered "Absolutely not! Having Glenda at my side for two years was essential. We needed that kind of help and support to want to change and to really change. I still have pretend conversations with her to sort out my thinking on how my classes are going." On another occasion she described what the coaching had done for her in this way, "It has given my a philosophy that helps me make decisions about all aspects of my curriculum and instruction. It has helped me to sort out what I believe is important for children to learn."

This past summer, after the intervention was over and after Laura had coached three of her peers, she was asked to talk to a new group of teachers who came to MSU for an Institute on Middle Grades. She passed out the set of coaching hints below as a part of her presentation. We had never specifically

talked about how to coach. Our conversations in the second year focused on specific problems she saw with her teachers. These hints came out of her own reflections on our sessions.

COACHING HINTS

1. Before you share observations, allow your colleague to express their perceptions of how the session went. Follow-up with positive reinforcement on all areas you thought went well.
2. Focus on one major concern or problem at a time.

   Provide feedback in written and oral form in the following areas:

   a) the quality of student interactions and involvement,

   b) wait time for questions and student responses

   c) pacing problems - don't wait for every child to get it,

   d) precise use of mathematical language

   e) questioning techniques -

   f) management problems
3. Provide suggestions on questions that could be asked to help focus the student's thinking on the mathematics. Offer assistance during the explore - keep the mathematics up front.
4. Write the teacher talk, students questions and responses where appropriate to help the teacher focus on specific situations.
5. Provide suggestions on how best to make mathematical connections to the models. Use statements such as: This worked for me..., My students had this problem..., What do you think about...?
6. Assist the teacher with understanding the mathematics that is involved. You may need to state that you had the same problem.
7. Provide focus for the teacher on the intent of an activity. Help them understand the connectedness and cyclical nature of the units.
8. Help your colleagues understand the LES mathematical model.

The Teaching Style Inventory provides another way to look at Laura's growth over the project. When she finished the project her teaching inventory score was closer to the ideal than any other teacher in the study. The Teaching Style Inventory was taken three times by the teachers in the project. This gives a pre-, interim, and post- record of Laura's thoughts about various aspects of teaching. All three responses are given here. The questions have been grouped into four categories: communication, organization, expectation, and teaching concepts.

Communication

		Pre	Int.	Post
2.	When students have trouble, I ask them leading questions.	___ 1	___ 1	___ 1
		X 2	X 2	X 2
		___ 3	___ 3	___ 3
		___ 4	___ 4	___ 4
	When students have trouble, I explain how to do it.	___ 5	___ 5	___ 5
14.	Almost all my questions in math class can be answered with yes, no, or a number	___ 1	___ 1	___ 1
		___ 2	___ 2	___ 2
		X 3	___ 3	___ 3
		___ 4	___ 4	___ 4
	Almost all my questions in math class require the students to give explanations.	___ 5	X 5	X 5

Organization

1.	Almost all help is initiated by students asking for it.	___ 1	___ 1	___ 1
		X 2	___ 2	X 2
		___ 3	X 3	___ 3
		___ 4	___ 4	___ 4
	Almost all help is initiated by my seeing the need for it.	___ 5	___ 5	___ 5
3.	Almost always many different activities are going on simultaneously during math class	___ 1	___ 1	___ 1
		___ 2	___ 2	___ 2
		___ 3	___ 3	___ 3
		___ 4	X 4	X 4
	Almost all the time the students are all engaged in the same activity during math class	X 5	___ 5	___ 5
4.	In class, students frequently work together on assignments.	___ 1	___ 1	X 1
		___ 2	___ 2	___ 2
		___ 3	X 3	___ 3
		___ 4	___ 4	___ 4
	Students seldom work together on assignments in class.	X 5	___ 5	___ 5

5.	When studying a math unit, students spend some time working in small groups to solve a big problem	___ 1	___ 1	X 1
		___ 2	___ 2	___ 2
		___ 3	X 3	___ 3
		___ 4	___ 4	___ 4
	When studying a math unit, students will not be working in small groups to solve a big problem.	X 5	___ 5	___ 5
10.	The furniture arrangement is the same for every math lesson.	___ 1	___ 1	___ 1
		___ 2	___ 2	___ 2
		___ 3	___ 3	___ 3
		X 4	___ 4	___ 4
	The furniture arrangement varies according to the lesson	___ 5	X 5	X 5
12.	I seldom change my approach throughout the semester (such as lecture-discussion, discovery, etc.).	___ 1	___ 1	___ 1
		X 2	___ 2	___ 2
		___ 3	___ 3	___ 3
		___ 4	___ 4	___ 4
	I change my approach frequently (from discovery to direct telling or from another method to something different) throughout the semester.	___ 5	X 5	X 5
15.	In my class, I give different assignments to students with different ability levels.	___ 1	___ 1	___ 1
		___ 2	___ 2	___ 2
		___ 3	X 3	X 3
		___ 4	___ 4	___ 4
	In my class, I give the same assignment to all students.	X 5	___ 5	___ 5

Expectation

6.	I encourage students to solve a given math problem the way I have demonstrated.	___ 1	___ 1	___ 1
		___ 2	___ 2	___ 2
		___ 3	___ 3	___ 3
		___ 4	X 4	___ 4
	I encourage students to solve math problems in a variety of ways.	X 5	___ 5	X 5
11.	In my math class I emphasize the basic computational skills three/fourths of the time or more.	___ 1	___ 1	___ 1
		___ 2	___ 2	___ 2
		___ 3	___ 3	___ 3
		X 4	___ 4	___ 4
	In my math class I emphasize concept development three/ fourths of the time or more.	___ 5	X 5	X 5

13.	Understanding why a given rule or procedure gives the correct answer is important.	___ 1 ___ 2 X 3 ___ 4	X 1 ___ 2 ___ 3 ___ 4	X 1 ___ 2 ___ 3 ___ 4
	Understanding the rule or procedure is not critical.	___ 5	___ 5	___ 5

Teaching Concepts

7.	I present a math concept first then illustrate that concept by working several problems (deductive)	___ 1 ___ 2 ___ 3 X 4	___ 1 ___ 2 ___ 3 X 4	___ 1 ___ 2 ___ 3 ___ 4
	I present the class with a series of similar problems, then together we develop concepts and methods of solving the problems (inductive).	___ 5	___ 5	X 5
8.	Certain topics are repeated (but in more depth) on a regular basis throughout the year.	___ 1 ___ 2 X 3 ___ 4	___ 1 X 2 ___ 3 ___ 4	X 1 ___ 2 ___ 3 ___ 4
	Once a topic is covered, that same topic is not covered again except during reviews.	___ 5	___ 5	___ 5
9.	When I teach a new topic, I spend a good deal of the time (1/3) trying to teach students to see similarities and differences between new and previously learned math ideas	___ 1 X 2 ___ 3 ___ 4	___ 1 X 2 ___ 3 ___ 4	X 1 ___ 2 ___ 3 ___ 4
	New topics are generally taught with limited reference to previously learned math ideas.	___ 5	___ 5	___ 5
16.	I usually use a game, story, or challenging problem to provide a context for a new math unit.	___ 1 ___ 2 ___ 3 ___ 4	___ 1 X 2 ___ 3 ___ 4	X 1 ___ 2 ___ 3 ___ 4
	I usually do not use a game, story, or challenging problem to provide a context for a new math unit.	X 5	___ 5	___ 5

17. I usually start a new math unit by giving examples and showing students how to work them.	X 1	___1	___1
	___2	___2	___2
	___3	___3	___3
	___4	___4	X 4
I do not usually start a new math unit by giving examples and showing students how to work them.	___5	X 5	___5

At the end of the project Laura frequently uses grouping; she asks students to explain answers; she uses many different approaches such as discovery, guided practice, and explanations throughout the semester; she values student understanding; topics are repeated but with more depth at times during the year; she uses games, stories, and challenging problems as contexts and motivation for mathematics; she no longer teaches only by example and practice. In all of these areas Laura made substantial change in her beliefs over the years of the project. The Student Inventory confirms the changes in Laura's teaching as perceived by the students. Over the first year the student data showed that the students perceived little change. Over the second year Laura's students saw a teacher who carried out in the classroom the same things that she expressed as her beliefs about teaching.

The change from a computational to a conceptual focus in the mathematics classroom requires a substantive change in what a teacher believes is important for students, in what teachers believe mathematics is, in what teachers believe mathematics is, in what teachers believe that students are capable of, and how teachers believe students learn. This is a complex, long term change process. Classroom coaching clearly contributed to the great change that occurred in Laura's beliefs and actions. It is equally clear that intensive, long term coaching requires considerable human resources. The pay off for this considerable investment is an effective, professional teacher who is already deeply involved in coaching her peers as a part of improving the mathematics instruction in her building. The project provided a professional support network for Laura. She is now building a network beyond her building that will continue to provide her professional stimulation while she also builds a network within her building and district that will provide such support for fellow teachers.

Appendix C

Cathy O'Neill: A Case Study of a Coached Teacher

This is a case study of Cathy O'Neill, one of the Middle Grades Mathematics Project's coached teachers. This report is separated into four sections:

I. Cathy O'Neill's Classroom Prior to the MGMP Intervention

II. A Discussion of the first year intervention with coaching

III. A Discussion of the second year intervention with coaching

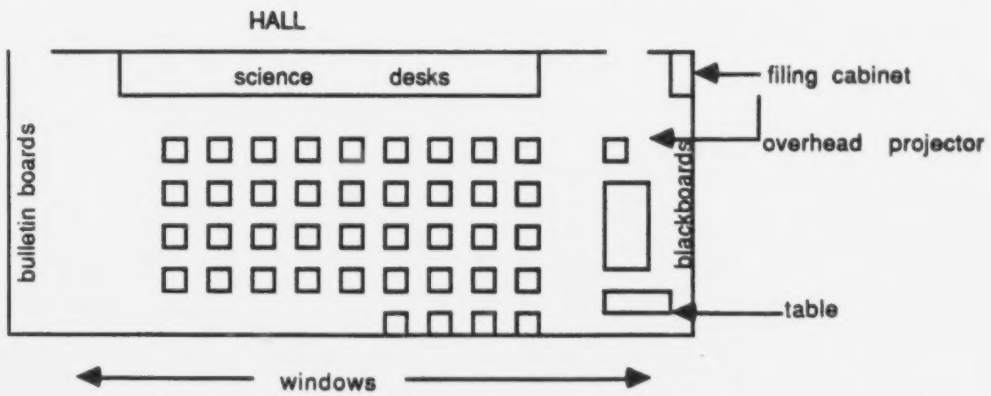
IV. Summary of the changes across two and one-half years of the project.

I. Cathy O'Neill Prior to the MGMP Intervention

Ms. Cathy O'Neill teaches six sections of 7th grade mathematics in a Junior High School. The Junior High School is in an old brick 3 story building in the middle of a small (16,000) town which serves the surrounding farm community. There are some small industries in town. It is approximately 40 miles from the university. It is a quiet picturesque town with a river runing through the middle of the town, surrounded by many fine old houses and several historical landmarks.

Due to the concentration of traffic in short halls feeding off a central open marble staircase, the halls are very noisy and congested between classes. During classes there are frequent interruptions with student help bringing notes to the classroom, some announcements on the intercom for class pictures etc. There appears to be a great deal of commaraderie among the teachers in the building.

Description of room: A very long drab gray color- old science lab with a large demonstration desk at the front and science stations on one wall. It needs paint and there is an odd assortment of desks in four very long rows and one short row near the windows. There is very little on the walls. Some student work is displayed on the back bulletin board. A diagram below describes the details of the room:



The curriculum consists of getting through "the book" (all the chapters). It appears that each math teacher is free to do what he/she wants and that there is very little discussion among the math teachers about the curriculum either within a grade or across grades. However, Cathy does discuss math with another teacher in the building who is also involved in the MGMP project . The math classes are grouped according to ability and Cathy has six classes, none of which is the top group. There appear to be several different levels among her classes. At the start of each year Cathy assumes that the students will remember very little math and that she must teach them whole numbers, fractions etc.; hence there is very little time for anything else. The class I observe is the sixth hour with approximately 25 students, some of whom are labeled "learning disabled". There were frequent absences and several interruptions in every class.

Cathy has been teaching for about 20 years and for the past 6 years she has been teaching 7th grade math in the junior high school. She is in her late forties with four grown children. In college she was a business major, but obtained an elementary teaching certificate when her children were young and she was a single parent. *She has never had anyone (except a principal for one period) observe her teach in the twenty years she has been teaching.* She is quite apprehensive about having an observer and a coach in her classroom.

In May of 1985, prior to the beginning of the MGMP intervention, Cathy's class was observed three times. The intention of these observation was to provide a baseline snapshop of Cathy's orientation, instructional style, her questioning technique, classroom interaction patterns, management style, typical lesson construction, and class routine.

The following are quotes taken from the observer's summary of the baseline data of Cathy's instruction in the spring of 1985:

> "There was a sense of respect in this room, teacher for students and students for teacher, and student for student. There was also a sense of learning and a concentration on math. Communication was highly interactive teacher to student and student to student with on-task topic."

The observer goes on to summarize Cathy's strengths and weaknesses:

Strengths	Weaknesses
Has students help each other	Maybe too structured
Has students work at the overhead	Algorithm oriented
Good rapport with the class	Holds tight control
Students cooperate with her	Could be more "loose" in terms of social organization
Shows a caring atitude	
Asks good questions	
Encourages the students and will try to take them a step further than the lesson	
Gives clear directions	
Establishes clear rules of conduct and classroom management	
Tries to involve all the students	
Focuses on content	

Cathy's Teaching Style Inventory concurs with these observations: she allows students to work together on problems, but **never changes her furniture arrangement;** understanding why a rule or procedure works is sometimes important; sometimes questions require students to give explanations; **she seldom poses open ended questions; she seldon uses concrete manipulatives or games** and **uses whole class instruction very frequently.** She does not perceive that her basic function as a math teacher is to convey her knowledge of math to students in a direct manner.

From our baseline data, the pre Teacher Style Inventory and her involvement with the first summer's workshop Cathy is very perceptive and a very good teacher. Her mode of operation is entirely teacher directed; her lessons are well thought out and she asks many questions which call for a single answer or simple explanation, but she seldon asks "why" or "how did you get the answer?", and seldom creates a series of questions leading to a discovery or generalization. A class period usually begins with a review question on the board that students work on while she takes attendance, etc. The review questions are cleverly stated - not just skill and drill. An example from the beginning of the year on whole numbers is the following:

Fill in the circles in the multiplication problem:

285
x OO
17O4
4O50
O6O80

Cathy spends much time insisting on full attention and good manners at all times. In the beginning of the year I thought these demands were excessive and based on the evidence of the unruly behaviour of the class- impossible to achieve. Her persistence on these rules of operation interferred with the mathematics instruction. But she perservered and by the time I was back in January the class atmosphere had changed dramatically. It was amazing to see the behaviour of the students. It was obvious that they liked and respected her and that she returned these feelings to each student. By this time her attention was free to focus on the mathematics - her class was with her. However, the strain of my presence and the observer together with the difficult task of shapping up her classes and teaching the entire period which the MGMP model requires was extremely demanding upon CR. In the beginning she would greet me with "the classes today are really out of control, I am not sure I will be able to carry on with the lesson." In fact she decided to teach probability to only four of her six classes because of the fatigue factor.

II. A Discussion of the First Year Intervention with Coaching.

This part will include the coaches observations with choice of coaching techniques and observed results. The Observer's field notes, the interviews of Cathy, the Teacher Style Inventory and Student Survey data will be included at relevant points.

The PROBABILITY unit was taught from Oct. 8 through the week of Oct 21. I was there every day from the 8th to the 21st. The observer was there for activities 6,7, and 8.

Overview of coaching

Prior to the start of the teaching of probabiliy I met with both the MGMP teachers after school. The two teachers had not gone over the unit since last summer, so they had very few questions. I gave a brief overview of unit and the instructional model and explained that basically my role was to help them in anyway I could. I also tried to explain which activites would be observed by an observer and why. During the probability unit my coaching discussions took place briefly after class and for about 10 minutes after school. It was obvious that this was all she wanted at the time. Because of the nervousness described above, I decided not to move around during the exploration part of the activities, but did take continuous notes which in retrospect may have added to her nervousness. My comments during our brief discussions focused on the positive aspects of the lessons I had observed with the hope of building up her confidence. Minor suggestions for improvement were sandwiched in between. At the end of the first week Cathy has a bad cold - missed one day - which gets complicated by a week end visit to Ohio; gets back late - starts school on Monday tired, not very prepared and still under the influence of a cold. Monday is not a good day. She almost quits in the middle of the activity. But the next day she has regrouped and all goes well.

Comments from the observer's summary:

> "On at least two occasions Cathy almost stopped the lesson, unwillling to go on, but continued because of the researcher's presence. Because of this, several good and interesting contributions by students were overlooked or ignored by Cathy. There were very few, if any extensions of thought presented to these students."

Comments made by Cathy in her first interview:

> She found the feedback from the coach somewhat helpful. "I would have ..liked more of an evaluation." ..."I would have felt very threathened by spring if I was introduced to this and saying we're going to come in and really critique you and so on, but I don't feel that way now." (Cathy felt her class was uncomfortable about observer, who was a nun and wore long robes.) She comments: "I don't know why they don't, they think she's glaring at them. ... But I think she's back there observing and writing down....she's just there writing down...."

Understanding the Mathematics

She was somewhat uncertain as to some of the sublties of probability. As a result she misses the point of some wrong responses and some of the questions and explanations from the students. Example: one fairly bright student keeps insisting that the lottery and some of the other games are fair because both sides have a chance. She doesn't pick up on the fact that fairness depends on equal chances. In fact after class she states that she is unsure as to why the lottery is unfair and we set up a time to discuss this after school. Later in the unit when she introduces the area model she again does not understand the relationship of the area model to probability. But this time she is

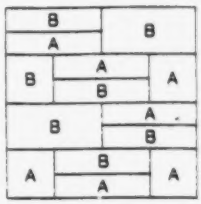
able to ask me some questions about using the area model in one of our discussion. One question involves" how do you know how to divide the given area into the various parts". I showed her an example and suggest that she take her clue from the denominator; the denominator will suggest how many equal parts will be needed etc. The next day in class she incorporated my explanations about area into her explanations of determining probabilities on a dart board. She did a good job and was obviously pleased with her performance- she beamed when I complimented her after class.

From the observer"s notes:

Cathy is going over the following problem for homework.

2. Find probabilities for this board. Would this board make a fair dart game?

P(A) = _____ P(B) = _____



"the teacher asked, 'who is favored:' A student answered B. The teacher asked, how can we make this fair?' A student who has suggested making triangles yesterday made the same suggestion today. He said that the boxes evened up if you did the division. The teacher asked, 'if I take four away from my B's what do I get?' The teacher commented, 'this is still flip-flop isn't it? How can I balance this?' A student suggested that they take two B's and make them A's. The teacher showed on the transparency how this would balance out the problem."

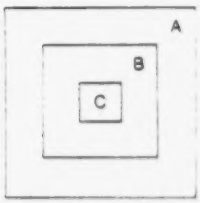
Later:

3. If a dart is thrown at random at this dart board, what is the probability that it will land in area A? What is the probability it will land in area B? What is the probability it will land in area C?

P(A) = _____ P(B) = _____ P(C) = _____

Scoring: If a dart landing in A scores one point, how many points should a dart landing in C score to make the two areas yield the same number of points over the long run? What should a dart in area B score?

Points for C _____ Points for B _____



"The teacher said to one of the students, 'you've got a ways to go.' This was the student who had made the triangles before and had a new way to do this game as well. The teacher said to this student, 'you're always coming up with a new way of doing things.' The teacher then said to the class 'all right let's draw these lines and see what probabilities we will get. What is my denominator? What is my bottom number going to be?' One student said twenty-five. The teacher said, ' just at random what is my probability of getting C?' The teacher repeated the "at random" question. With the class the teacher figured out the probabilities for each one in the section. The probabilities were 1/25, 8/25, 16/25. The teacher asked, 'how can I even this up?' The teacher further commented, 'if I get a point for A, a point for B, a point for C -- that certainly isn't going to be even.' ....One of the students

> suggested that every time you get a C give sixteen points. Then the student suggested that you give two points for a B and one point for an A. ....The teacher then showed how this point system would work. One of the girls though said she didn't think it was right. She said that if you get in the middle which is the C section you should get more. The teacher explained that she would get more if she got in the middle. The point system suggested by the students did work. The student who suggested the triangle made the suggestion to spread out the C's. The teacher explained to the class that what the student did was cut this particular game into triangles but the student did not have the same unit space for each triangle. The teacher stated that you need the same unit space."

The teacher is correct; you do need congruent units - but congruent triangles would work just as well; the student was on the right track.

In general her *questions* are good but she doesn't challenge answers or ask enough open-ended questions. In addition to the above examples I begin to suggest asking more questions which require students to explain how and why they got their answers during Activities 6-8. She begins to ask more questions on how to make situations fair and why they think their answers are correct. Good questions lead into an interesting discussion on how to simulate the paper-person situation. However, in the end she imposes her method of simulation.

Comments from the observer's notes:

> "There are many ways you could do this. Many are too time consuming for me to pass out. So I have a pack of cards here. how can I pass these out to simulate what we are doing?"

Comments from the observer's summary:

> "This class was a difficult one in terms of the instructional model. Not letting the students choose a method seemed to take some of the energy of the lesson away. The fact that Cathy passed out the cards was a good example of her ability to control and direct student activity. This would be a good lesson for discussing what the purpose of this activity really is. Something seemed to get lost here."

Before Activities 7-8 on expected value, Cathy, her colleague and I had a rather lengthy discussion on expected value. I think expected value was a new idea for her. I modeled several expected value situations from games already discusssed in class and talked them through the basketball and paper-person situations showing them how to write down the information etc. She imitated our discusssion on these activities but I don't think she has a deep understanding yet of expected value - she tended to rush the summary .

Launch and Summary

It was obvious that CR *plans very carefully* and follows the script religiously. She asks most of the questions listed in the script and tries to do all parts of each activity. She gives superb directions and explanations.

As she teaches the unit during the day she adds small details which aid in the flow and clarity of the directions and explanations. When she first introduced the tree diagrams on the board to help the students read the branches (a difficult task) she used an enormous eraser which she held under each branch as the class read the results. A similar device was used to read the possible paths that might occur in the mazes in Activity 5. Most of my suggestions on explanations and directions are minor since this is her strong point. But when I suggest that she moved too quickly to a short abstract form for probability, P(y) = , she quickly adjusted to a probability statement in words (P(yellow) = 1/3) and in writing a complete statement about probability rather than just the fraction 1/3.

Other evidence of resonding to suggestions in the area of explanations (both in the launches and summaries) occurred when I suggested that she start asking some questions on expected outcomes such as "how many times would you expect to land in area A in 100 spins?" to set the stage for expected value and to clear up any confusion between "expected outcome" and "expected value". Her questions on this topic were very good.

Pacing

Pacing is another aspect of the MGMP model with which Cathy had trouble. She had a tendency to stay on each activity too long and to go for "complete" understandings on the first go around. A major characteristics of the MGMP units is that each unit develops understanding of a "big" concept in math. In the probability unit the concept of probability is developed in many different settings through both experimentation and theoretical discusssion. The only rule used is the definition of probability. Understanding of this only comes after several activities. Cathy spent too much time on homework sheets. Sometimes the period ended with time left over . It took many suggestions on my part to get her to omit certain things and to speed things up. But her lack of complete familiarity with the math involved and with the units themselves may have added to the slow pacing . It took more than 3 weeks to do the 7 activities and part of Activity 8.

Exploration and Grouping

The "exploration phase" of each lesson was almost entirely missing. It was clear from the start that putting students into groups was not only foreign to Cathy but something she also was dreading. On the first day I was surprised to see that she grouped the students to do worksheet 1-1 as an exploration putting off the lottery game until the next day. I was also surprised when she gave no directions for how to form groups which lead me to believe she had not done this part with the other classes. There was a lot of noise and confusion - something she tries to avoid. The odd assortment of desks does not help. It is not until Act . 4 with some prodding from me that she starts to give some directions for grouping. In fact after class she claims she likes her new rules and will keep them. (The rule consists in her assigning the students to specific groups.) In fact for one of the earlier groupings she kept students in rows and tells them to each spin 50 times and then share their data with the person behind them. Cathy 's role in the exploration is just one of giving directions and answering questions arising from confusion on the students part.

The role of observing , challenging and posing questions is missing.

Observer's summary of the probability unit:

> "Cathy seemed to teach the three activities observed (6,7,8), as three separate segments of information. There was not a sense of cohesion in that these three developed related concepts. It seemed as though Cathy herself struggled with the content and tried to direct the instruction along the path of her own limited understanding. She was not tolerant of any remark seemingly 'far-out' in terms of suggestions for doing some activity, even if the suggestion was related to the issue at hand. Again it was during this unit that Cathy was trying to establish her authority as teacher in the classroom.
>
> In the Launch phases, Cathy seemed fairly enthusiastic and managed to capture the attention of the students. She drew out the story lines in very interesting and captivating ways. However, she held a tight and directive line during the mini-challenges. She maintained a teacher-directed approach through the first Explore and did not allow the students to work on their own. The second Explore was an exercise on the spinner and was presented as that, without much preparation for going beyond just collecting the data. For the third Explore, in which the students were to choose a method of simulation, Cathy decided how the task was to be simulated and everyone did it exactly the same way. Again a sense of experimentation and conceptual understanding was lost. There was a sense that Cathy didn't believe the students were capable of the task in the first Explore and that she could't face the possible confusion of the third Explore. The Summary phases consisted of collecting data and doing the worksheets. There was seldom a clear connection make between a particular worksheet and its preceding Main Challenge. There was more a sense of explaining the material as clearly as possible and getting on to the next idea.
>
> Cathy would occasionally give a worksheet for homework and when so many students did not bring it back she refused to go over the material, or did so very quickly. The exercises were being used as points of discipline and establishing expectations. The mathematics seemed to suffer in the long run because the major concern of management was not yet revolved. Yet this deficiency in the mathematical content could also be attributed in part to Cathy's own lack of understanding the mathematics."

Observer's commments at end of activity 8:

> "The teacher is definitely sincere and obviously has a specific orientation in her classroom. What isn't clear is the goal of her orientation. Possible goals could be classroom management, content, learning, interaction, her own feeling of success, a feeling of success in the students. Right now it is unclear."

Conclusions

In general most of the coaching centered on helping Cathy become comfortable with the mathematics of probability and with having other adults in the room observing her. Some progress was made on the quality of the questions and discussions in the launch and summary phases of MGMP. The explorations and grouping of students definitely needs work. It is obvious that the strain of this project is taking its toll on Cathy - she is fatigued and her patience

in class is sometimes very short. Consequently the students suffer the brunt of her feelings and act accordingly. But in general the students enjoyed doing the probability unit. We are becoming friends and I am treated one day with a box of raspberries from her garden and homemade goodies for some of our after school sessions.

Comments from Cathy's first interview:

1. Discribe all changes you had to make in your usual teaching style.
"allow for grouping amd more class discussions (interactions); total class time spent with class which left no time even for "catching" your breadth"; no daily grades."

2. What about the content and student outcomes? "Pleased with content, but expected higher outcomes in some instances. Some content seemed too difficult for some children - too much too fast-"

3. What changes would you make if you teach this unit next year? "Break it into 2 or 3 shorter segments; change the lottery drawing so it becomes more meaningful more quickly (really drags); Have folders left in room- next year and would encourage taking them home to share as we progress; Would also have more expectations as work done on work sheets."

4. What, if anything, about the way you taught this unit do you think will transfer to your teaching of other content? "More grouping - more involvement of students - Better preparation-"

5. In evaluating the summer workshop she found observing the staff teaching the units quite helpful and the the discussion and feedback during the workshop very helpful.

6. What changes would you make in the experiences you have had so far? Initially - give a better indication of total time involved in program - has been already far more than I anticipated - and although very worth while I am feeling very frustrated and **'panicky' about covering the remaining material that I am expected to cover."**

Additionally from the first interview Cathy claims that the big ideas in 7th grade mathematics is "to get them to see some of the applications ...and be able to state something from a bigger area of math, ...that is not just the idea of completing a page..."

She also believes that sudents' "capability is much higher than their level of functioning"

On the importance of skill and drill she thinks "probably it has been more important previously. I get very upset when I feel like I have so much to cover.....And they don't have some of the basic skills, I don't like to see seventh graders counting on their fingers, and....I think it is important. I think it can certainly be overdone. I see no point in doing pages of something that a child knows how to do. I don't see busy

work, but I think in order to learn ...you can give some variety so they can do some skills that are rather important." In response to how do you know if students understand she says "..by the questions I ask them, maybe certainly by their grades they get on particular assigments. But just like this thing with improper fractions, I realize they don't understand. ... I'm still drawing pictures to let them see that.....16/5 is actually a lot of parts and pieces....And looking back now, I taught fourth grade, I did not spend nearly enough time on that kind of thing.....I'm sure I am using some of these things even if I'm not aware of them.....Trying to get more activities involved, even taking the fractions and drawing pictures of it, which is someting of an off-shoot of this (probability unit and transfer task)."

TRANSFER TASK 1

Planning Session

Before our meeting I suggest that they pick two or three activities that would involve all three phases of the instructional model. Since Cathy was concerned about the length of time spent on probability (almost a month), I suggest they center their transfer task on material which they are teaching. This turns out to to fractions and so "factors and multiples" is the general area both teachers decide to use. The other teacher suggests using the Factor Game and the Sieve of Eratosthenes. She says she always does the sieve first so that the students can use the results for finding primes etc. Cathy has no suggestions - it maybe that she is uncertain about the nature of the task at hand. We have a short discussion about the model and that the sieve probably does not have a very good explore part and does require very careful directions. The other teacher has the Factor and Multiples unit from the MGMP and so we discuss starting their transfer task with the factor game and what mathematics can come from this game. We discuss the possibility of using the product game and creating another activity centering on the 100's chart. For example, an activity which would have the kids involved in an open-ended investigation of finding patterns in the chart. Many of these patterns would involve factors and multiples. I gave them several suggestions and then sent them a list of questions concerning various patterns, but stressed that they did not need to know all the patterns - that the kids would have fun adding to the list. We ended by setting a date for the transfer task. However, when I called to confirm the date, Cathy said she was not ready and we postponed the date by a week. They had also decided to do only two activities: the factor game and then the sieve.

The Execution of the Transfer Task

Cathy meets me at the door with the greeting that " the kids are wild today and to be prepared for anything"- I am to take this as an excuse if the activity fails. The factor game took three days! The first day consisted of a lauch which was very well done by the use of questions to review factor, multiple and how to find each. The explore consisted of groups of two playing the factor game on a 30-board. Cathy reverts to letting students pick their own partners and this results in some unnecessary noise. The kids are enjoying the game and Cathy moves about answering questions. A short summary occurs.

The second day Cathy greets me with the announcement that she is going to put the kids in groups of four to play the factor game on a 49-board. Apparently she did this with some of the morning classes and it went well. She

also mentions that this material is only covering one page in the book and she has a whole chapter to go on factors and multiples. I told her that the students will come away from these activities with a deeper understanding of factors and she will be able to move faster as a consequence. She is very skeptical of this bit of news. The explore for this game is fantastic. It is the best explore for this activity that I have ever seen. *This is the first time that I have moved about the room in an exploration.* The students are very excited and develop many strategies. For example, one set of boys decide to use illegal moves and eventually they cover the entire board; but this involved challenging each other as to whether or not a move was legal or illegal and then requiring the challenged person to prove his move. In other groups partners were discussing and developing strategies. More than once opponents were asked to prove the numbers they circled were correct. There were no calculators but most of the students were keeping track of their scores. Many students were using shortcuts for adding like grouping by 10's which they had obviously learned in Cathy's class. Because of the drill and training done by Cathy the students are very competent on mathematical skills and techniques. Cathy picks up on the fact that there is much learning and excitement going on and asks me if she should end the explore. Since most of the groups were still working out new strategies and re-plays were being called for by the loosers, I suggested that she let them continue. This took the entire period. The next day was spent on summary with about 15 minutes at the end given for working on one of the homework sheets that went with this activity. The questions and the discussion in the summary were good, but Cathy followed for the most part the script provided by the MGMP unit.

Due to final exams I was not able to observe the sieve activity , but from our discussion there appeared to be no exploration or summary and the activity was all teacher-directed. This was the activity where I was hoping for some creative extensions by Cathy as I suggested in our planning meeting. But it is clear that she does not have a grasp of the model or of the nature of the mathematical tasks. However, she likes doing the sieve with the color coding of the primes being sifted because of the patterns that emerge and she plans to use this activity next year.

Summary

In our debriefing session I went over how the factor game could be kept to 2 days with the first explore consisting of playing one round on the 30-board and then moving to the 49-board, since her class was quite competent in this area. We discussed how pacing gets better with repetition of the activities. I briefly discussed the sieve and that it is difficult to execute and perhaps some other activities would have been more appropriate. I made a note to myself that more discussions were needed on the model. However, due to the excitment and learning that went on in the groups of four during the playing of the 49-board game, **this is the first time that Cathy gets a glimpse of the value of a true exploration.**

Observer's summary of transfer task: (only the first activity was observed.)

> During the Launch Cathy played two games of the Factor-Game with the class. She won the first game and they won the second game. By the time they started playing themselves, they seemed very clear on what the game required. The students played with enthusiasm and several sets of game scores differed by

only one. Some students were using illegal moves to their advantage and raising their scores. .....Cathy had the students play the 49-board before they discussed the 30-board. For the summary Cathy went through the First-Move sheets, one number at a time through 49. She gave the students the activity sheet with questions about first-moves for an assignment.

I do not feel this Transfer-Task adequately demonstrated whether Cathy has grasped the essence of the LES Instructional Model. She followed the prepared script too closely and was not challenged to conceptualize the lesson with untried content. What did come through was the enthusiasm and the insight of this class. They performed remarkably well in this lesson. They were interested, involved, and capable of seeing the nature of the activity. Cathy again displayed her need to direct and control but was obviously less threatened in her authority role. The class seemed much more subdued than during the first observations. They raised their hands instead of talking out. They asked permission to move about the room and several offered to pass out papers or materials. Cathy, however, retained the responsibility for passing out papers.

It is not possible to conclude if Cathy, at this point, has assumed to herself any or all of the conceptual framework of the LES Instructional Model."

Comments made by Cathy in her first interview: (The question numbers refer to the question numbers on the interview>)

Q2. As you reflect on your Transfer Task, list and describe any and all important changes you made from the way you taught this content last year.

A. "1. Color coding the sieve rather than just crossing out the numbers. 2. Looking for patterns within the sieve. 3. Using the (factor game's) 30 board and 49 board for introductory material."

Q4. What if anything, about the way you taught the Transfer Task do you think you will use in teaching other content?

A. "Strive to develop tasks which require more involvement of the student."

Q6. What changes would you make in any of the experiences you have had so far?

A. "Initially - give a better indication of total time involved in program - It has been already far more than I anticipated - and although it is very worth while, I am feeling very frustrated and 'panicky' about covering the remaining material that I am expected to cover."

SIMILARITY

Planning and Overview of Coaching

We have an extensive after school planning sessions. I have divided the discussions into two parts: mathematics and pedagogy. The following outline was used as a guide. A copy was given to each of the two teachers.

Mathematics

Driving Mathematical Goals

1. Properties of similar figures:
   angle measure does not change
   ratio of corresponding sides is the same
2. Growth factor (scale factor):
   length grows by the scale factor
   perimeter grows by the scale factor
   area grows by the square of the scale factor
3. Test for determining similar figures
4. Drawing similar figures
5. Applications of similar figures

Misconceptions (sources of)

1. perimeter is a length
2. area is a covering; it grows by the square of the scale factor
3. corresponding sides - how do you decide

Pedagogy

Exploration

1. Look for student strategies during exploration
2. Ask questions, offer extensions and/or challenges

Summary

1. Refer to student strategies
2. Let students discover patterns in the charts
3. Ask more "why" and "how" questions
4. Challenge student answers.

Time outline: we discussed in detail the first three activities and the possible length of time to spend on each. This outline was also handed out.

Activity 1 Stretchers (1 day)
An intuitive definition of similarity

Activity 2 Morris (1-2 days)
We discussed this in detail - in particular how to create all the Morris'; each group would end up with a set by each student doing two and then sharing their results. I suggested that in the summary they ask questions about the chart and go lightly over the growth of area and perimeter as these will keep coming up in each activity.

Activity 3 Rectangles (1-2 days)
We discussed how to use Morris' noses to launch the test for similar rectangles; suggested they add another nose and ask if it is similar. Reminded them that many students would not know how to use the grid for measuring area and lengths.

Postscript to the planning: I asked if I could move about during the explorations. I planned to use my observations and actions as guides and hints as to how to use the explorations. I also suggested that I would take notes on duplicate paper and give them a copy which we could use for discussion or which could be used by them in their teaching of similarity.

Understanding the Mathematics

Cathy only did the first 5 activities for a total of two weeks. She understood the mathematics much better than in probability. It was clear she felt more comfortable with this topic. In general she enjoys geometry, even though the growth of the area was completely new to her. The pre-planning session may have helped.

The class atmosphere is completely changed from last semester even though she has the same set of students. It is absolutely amazing what control she has over this class with out being destructive. The students are happy , eager to participate, show respect and have obviously become very skilled in mathematical algorithms including such things as mental arithmetic and estimation.

From the observer's summary:

> "...The struggle for control was no longer a major issue. It was obvious that Cathy had sucessfully convinced the class of her role in the classroom and on the rules for behavior which she expected them to follow. Cathy herself seemed more free and relaxed in her role. She had to do much less reprimanding and paid much less attention to management control. She focused more on content and seemed much more prepared and involved in the mathematics. Her negative remarks now centered on her own lack of seeing how concepts or activities fit into the whole picture rather than on student behavior."

The MGMP Model

In general all parts of the model including the launch, exploration, summary, pacing and questioning techniques were much improved. Rather than speak to each part individually I will offer some general observations to support the improvement.

Activity I. First of all when I walk into the room Cathy has new desks with bright orange flat tops which are in **groups of 4**! The room is much brighter and cheery looking. Still Cathy meets me at the door with "wow I am exhausted - I have been doing this all day." She is very nervous. She describes confusions that occurred earlier in the day when she was using rulers to measure some of the similar figures and that the measurements were all different for each student. We mention in the unit to use rulers, when we really meant to informally compare the measurements in two similar figures using a straight edge, pencil, etc. Cathy pays close attention to the script. I gave her a short explanation of what we meant and suggest that she use a piece of paper or pencil. The first activity goes very well and is completed in <u>one period.</u> She models the use of the stretcher very well picking up on all the important parts such as the anchor point, where the knot should be etc. The students have no problem with the stretchers in the exploration and enjoy it. During the launch she models the use of 3 rubber bands after asking the students to predict what will happen. She misses some opportunities to use the student strategies such as some students subdivided the triangle into four congruent triangles. During the exploration mentioned to Cathy that one or two students responded "4 times" when I asked how pac man grew. When I asked what they meant, they said "see four of these pac mans will fit in the large one. She picks up on this idea in the Summary. There is a good discussion on "how much larger?" - some students might be answering area, and some might be answering length.

She cautions them to specify area or length. I suggest that she capitalize on this in the next activities.

Activity 2. The second day Cathy is very relaxed, obviously pleased with her self - the activities are going will; the grouping is working- it may be due to the nature of the Morris activity. Her directions are superb: She picks up a suggestion from our planning session and has each student do two Morrises - the girls do Morris 1 and Doris and the boys do Morris 2 and Boris - no confusion. The launch and explore take a bit more than 1 day. I suggested that she pick up on the rubber bands and ask how we could draw a Morris 2, 3 with a stretcher, thus connecting the two activities. This works well - tells class that they now have two methods for drawing similar figures. I also suggest that in the summary she ask some "reverse questions" from the chart such as "If Morris' nose has a perimeter of 42, what did we grow Morris 1 by?" This went very well, except there still is not enough challenging of student responses and she has a tendency to answer a question herself if no one gets the correct answer, rather than redirecting the question or finding out why they cannot answer the question. Pacing is much better - only two days on Morris.

Comments from the observer's notes:

> (after an excellent game of tic-tac-toe as an introduction to graphing she preceeds to give very clear directions for the Morris activities.)
>
> "...She told the class that they must plot these points in order to draw Morris I. The teacher then went over the first set of points. The teacher said, 'think of these as being a paragraph in your English class.' She told the students at the end of each grouping there should be a period. This would give them some idea of how to draw the picture...."
>
> "...'when you draw Morris II, see how he changes. Does he get smaller, larger, fatter, stay the same?' One student said right away, 'twice as large.' the teacher said, 'he says gets twice as large. Why do you say that?' The student said, 'we're multiplying by two.'.....The teacher then went through one point for Morris III, ...one point for Borris, ...one point for Dorris. The teacher went through this process by asking questions of the students in order to figure out the first point."

Later from the Explore part of the activity:

> "..The teacher then goes around the room checking and re-explaining to individual students. To one student the teacher said 'this looks really good.' The students are placed so that someone can help them. One particular student who had been a problem in class is responsible for helping another student. Everyone is working ... The students are discussing their results of their pictures. One of the students said, 'this one will be bigger.' Another student said, 'this one will be bigger.' Another student responded to this remark by saying 'right cause we multiplied by 3.' ....Every one is on task. .....The teacher asked a student what he thought Boris would be. Several suggestions were given by the student on others such as a mouse or lobster. The teacher is helping individual students. The teacher said, 'remember you always go back to Morris I.' ...The students seem involved in this activity. The teacher said, 'all right boys and girls, I want you to stop now.' there were several groans from

> the students. ....The teacher is collecting the papers. Students are talking to each other. Above the talking can be heard the names of Boris and Doris..."

The observer's summary of the first day of this activity:

> "This was a beautiful class. The students entered immediately into the tic-tac-toe game and seemed excited about graphing. They were right on target answering the teachers questions and talking to each other about the activity. There was a sense of interest, curiosity, and learning going on today. Everyone seemed to be on task and wanted to figure out what was going on. The teacher gave very explicit directions and took time to cover every possible area of confusion. She encouraged students to help other students. It seemed to be a well organized, well functioning mathematics lesson."

Activity 3 . Cathy puts up the transpareny of Morris' noses and asks "Which of these noses are similar?" As soon as the transparency goes up , for some reason,I know immediately what the class is going to respond since the Morris activity was done yesterday. The students respond Morris l and Dorris are similar because of the same base etc. It is not clear why - it just looks and feels good. Cathy expresses some concern about this confusion and I tell her that it is still early in the unit. The students use a variety of techniques to count the area of the rectangles - I make sure to mention some to Cathy and she makes a point to ask for some strategies in the summary without me reminding her to do so. She asks the questions listed in the script for the summary; it is not clear if she has a sense of where the questions are leading and at one point when she asks for a quick way to find perimeter, the students give her two correct answers but what she really wanted was for them to use the scale factor. She finally tells them they could have used the scale factor and multiply the perimeter of the original rectangle by the scale factor to get the new perimeter. Scale factor is a new concept for the entire class including Cathy - it will take some time to digest this concept. Activity 3 takes one day since she takes me up on one of my suggestions and uses a few left over questions from the summary of Activity 3 to launch Activity 4.

> During the **Explore** I was delighted to watch one student try to count an area with a large number of squares - he kept losing his count. Out of frustation he finally counted the bottom row and then paused - looked at the rectangle and said to himself "there are 12 of these rows so that the area must be 12 times. Oh this is the area formula!" As he says this last statement he looks at me and beams with his discovery.

Activity 4. She spends a bit too much time going over the worksheet from activity 3 and the students get a bit restless. The scale factor concept hasn't caught hold yet and she seems unwilling to move on without a better understanding. When she gets to the launch she models reptiling very well; makes some connections back to rectangles. The reptiling pieces are all cut out from the morning classes and the explore goes well; students are a bit hyper -it is Friday but they are enjoying the activity. **Cathy moves about and asks students to demonstrate why their reptiled figures are similar to the original figure. Students were able to respond.** Act.4 continues on Monday. When I arrive Cathy greets me excitibly and tells me about some of the neat things that were going on in the groups during the day. She let them continue with the second set of reptiling

which is rather challenging. I think this was a bit too much and some students get frustrated. The pacing is off. Summary goes smoothly; the students like coming up to the front of the room to demonstrate. She uses a chart to pull the reptiling of triangles together and picks up some information on how area grows.
I compliment her on her room arrangement. The desks are in groups for all the phases of the model. I say "isn't it convenient how you can stand in the middle and monitor all the groups". I missed the next day. When I return she greets me with "Kids are getting tired - I may end with activity 5." (Is Cathy getting tired?) I make some suggestions in writing about what could be cut the next time through to pick up the pace. She tried to do too many of the extensions in reptiling and this may have caused the class to become a bit bored.

Activity 5 goes fairly well but the enthusiasm is not quite there - a combination of the intensity of reptiling and the fairly routine tasks of determing similarity of triangles.

Comments from the observer's summary for this unit :

> "Cathy seemed to teach the three activities observed (2,3, 4) as a cohesive unit. She herself seemed to have a clear grasp of how the concepts fit together and how the mathematics of one activity led into the next one. She was much more open to student responses and seemed to enjoy the unit. However, her tendency to carefully direct and often tell the result of their activities was still operative in Cathy. When she became somewhat unclear or frustrated, she would answer her own questions and tell the students what they should be finding.
>
> In the Launch phases, Cathy was enthusiastic and engaged the students immediately. She was able to use past knowledge and draw the students into the activities. She was clear in her directions both to the students and with her own goals and objectives. The Explore phases seemed much more a student oriented time. Cathy gave careful directions before each Explore so the students could begin at once and she could effectively help those with questions. She walked from group to group and seemed to enjoy watching the students work. There was no longer the fear of losing control or the fear the students could not master the material. Cathy asked a few probing questions and talked to the students about thinking harder. The Summary phases seemed to be more difficult for Cathy. She had a handle on the mathematics but wanted the students to see every possible outcome of the activity. There was the sense she gave them so much in the first Summary that she was constantly trying to sort it out afterwards. In this unit, however, it was clear that Cathy saw the mathematical connections and she was continuously trying to make them clear to the students. It was in the Summary phases that Cathy usually answered her own questions rather than have the students discover the connections.
>
> During these activities there was not the previous struggle of unfinished homework or the use of exercises as points of discipline. **The mathematics content was the focus.**

The Planning Session and Overview of Coaching

On April 30, 1986 I met with both Cathy and the other math teacher in the project after school to discuss their transfer task. They had decided to do something with percent. I bought out the Oregon Resource materials which they had not seen before. They were very excited about the contents but wondered how anyone would have the time to look through and pick and choose. None the less they both planned on obtaining the complete set for their school. We discussed what about percents they wanted to teach. Up to this time Cathy had been worried about not being able to cover all the material in the book. Her comment was "by the time they got through the two units, probability and similarity, and the transfer task on factors and multiples and went back to the book she found she had covered much of the content in the book: fractions, equivalent fractions, decimals and some percent, area, perimeter, polygons, and applications". Further more Cathy had talked to the 8th grade teachers and inquired what the beginning 8th graders knew about percents and the 8th grade teachers said nothing - this is after the 7th grade teachers had taught 3 chapters on percents at the end of the year. So Cathy's comment was **"since they don't remember anything after teaching 3 chapters on percents, I am throwing out the book - I want to just focus on understanding percents".** This is a big breakthrough on her awareness of the power of understanding important concepts and her control over the curriculum.

The teachers had some ideas about using plastic transparent 100 grids. We decided that the mathematical goal for the activities would be to understand that percent was a fraction with denominator of 100. The challenge for developing a sequence of activities was to answer problems about percents using only the notion of equivalent fractions. That is to try to look at all percent problems as one of the parts, A, B, C, is missing in the equivalence: A/100 = B/C. I don't think they quite understood this challenge as their book refers to three different types of percent problems involving p, r, etc. The connection back to equivalent fractions with one having a denomiator of 100 is not fully understood, but they commit themselves to trying. The transparent 100's grid will provide the concrete experience and the students will be able to use them throughout the activities. Each activity should have a launch, exploration, and summary. We talked about the characteristics of each phase of the model. We also discussed the connection to the probability unit where we represent probability as percent and use a 100 grid to analyze the outcomes.

Execution of the Transfer Task

The two teachers had very carefully selected a set of activities mostly from the Oregon Resource materials. When I saw the set of activity pages my first thought was "oh no, the students will be going through a bunch of activities with no clear notion of the mathematical goals". This was not the case: **Each activity was enveloped in a launch, explore, and summary, but more importantly the mathematical connections were established between the activities. It was clear to me and the students that each activity was building to a deeper understanding of percents.** This was not apparent by just looking at the activity pages.

After the first activity Cathy commented that she thought the pacing was slightly off and we discussed what changes (minor) could be made the next time. My comment to her was that the first time through it was difficult to establish the best pace, but the important thing was **to reflect on these kinds of concerns and make the proper adjustments the next time (as she had just done).** As part of the launch she encouraged students to estimate the area before they actually counted it. I was disappointed to see that the students were not in groups. I pointed out that the students could have shared more of their strategies for determining the percent of the area which was shaded. There were some great strategies being used by students. These were based on their knowledge of area which might have come from the similarity unit. Some were using the complement or the unshaded part because it was an easier area to determine. Even without the groupings the students were encouraged to share and discuss their results with one another, which they freely did. While each activitiy had a mathematical goal and each fitted into the big picture, not all of them had an intrinsic challenge for the students to solve. Creating challenging problems is very difficult and requires much time, planning, relfecting, and searching. In general teachers do not have sufficient planning time to allow them to do creative curriculum development.

Quotes from the Observer's notes on Activity 1 (1st day)

> Launch:
> The teacher said: "We are going to go back to someting we did a long time ago." The teacher then reviews the the basketball problems that were done in the unit on probability. This problem involved a 60 perent free throw shooter and a 40 percent free throw shooter. The teacher put the grid of 100 squares on the overhead. She then reviewed how sections were marked off and each section stood for a certain percent. The teacher said: "Today we are going to be extending the idea of percents." The teacher then put a worksheet on the overhead which had drawn figures on it. She talked about finding the area of these figures. They are going to use grids to count squares in order to find the area. The teacher showed however that if they put the grid on top of the figure the outlines of the figures faded into the grid and they could not see what the figure was. So the teacher told them to shade in the figures on the paper. Once they were shaded in they could put the grid over it and count the squares.

Comments from the written coaching notes on activity 2 (2nd day)

> "If both of these activities are done on the same day - it would show how the 100's grid is used to write the percent of an area which is shaded, and the reverse, given a percent, shade in the appropiate area. These would be two good points to try to generalize in the summary. This might be a good time to ask questions like - "If I give you 20/100, what percent is this?" "What area is this on the 100 grid?" You might even slip in something like given `20/50, what % is this or what area is this?" Other questions can relate to other area models such as circle, triangle, line segment - given a shading find the % and conversely.

Quotes from the observer's field notes for activity 3 (3rd day):

> Mini-challenge in the launch phase:
> "Okay, now this is what I want you to do. Now listen." The teacher then talked to the students about finding percents for their grades. She wanted the students to turn their scores into percents. She talked about the percent being the numerator of a fraction with

100 as the denominator. The teacher then showed the student how to turn their scores with the denominator of 20 into percents. The teacher said, "take your score and turn it into a percent. Make it an equivalent fraction with a denominator of 100." ...They are giving her their grades in percent.

Later after handing out the activity sheet for the explore:

The teacher said "okay, I want you to think back to the first day we did this." The teacher then referred to percents and changing them to fractions and decimals. The teacher said "we are going to build a proportion. Five is to 10 as what is to 100?" Several hands are raised. A student answered, "50." The teacher asked, "why?" The student said, "10 times 10 is 100 and 5 times 10 is 50." The teacher said, "shade in 50. This is not an art class, so do it quickly."

In this problem 16 out of 20 are shaded. The teacher said, "you've got 16 out of 20 shaded. ...."so 16 is 20 as how many out of 100?" A student said "80". The teacher asked, "how do you get 80?" the student said, "five times 20 is 100. 5 times 4 is 20 and subract that from 100 to get 80." The teacher said did you hear how he did that?" The teacher explained it again.

Later in the summary:

The teacher goes over the last two problems. The teacher asked, "how many out of these 20 are shaded?" A student answered, "8". The teacher then finds the equivalent fraction. This showed that 40 percent of 20 is 8. The teacher then takes the second worksheet. The teacher asked, "40 % of 100 is what?" There is no answer. The teacher asked, "40 isn"t it? Fill in 4. A student asked "that's it?"
....The teacher is going to the next problem. The grid is bigger than 100. The teacher said, "first of all build your fraction, 25 over 100. The grid has how many squares?" A student answered, "200". The teacher said, "set up your proportion; 25 over 100 or ___over 200. How do we find the answer?" A student answered, "times 2." The teacher said, "times 2. Color in 50 squares."
... The fraction from the next problem was 10 over 100. The students were to get 30 in the denominator. The teacher asked the class how this could be done. A student said, "multiply by 3 and then reduce to get 30 on the bottom." The teacher suggested reducing first and then multiplying.

Anecdote from the coaches notes on the summary in the third day:

Cathy was calling for answers and having students explain their strategies. On one particular question a boy recognized by the class as being quite bright gave an answer and a very well articulated strategy for obtaining the answer. Prior to calling on this student, several students' raised their hands indicating a willingness to answer. So after the first student's answer the teacher turned to John and said "What was your answer?" John responded "I got the same answer, but I did it wrong." The teacher said "How did you do it?" John gave an explanation of his strategy and the teacher replied "that's very good, John, that's a good way to do the problem." John, who was sitting in the front, slapped his hand on the desk and excitedly exclaimed "you mean there is more than one way to do these problems!" John is a learning disabled student; he was first called to my attention on my first visit, when I was commenting on his intuition into a probability problem and Cathy told me that he was learning disabled. I not sure what his problem was, but he certainly blossomed in this class.

I observed three days of this transfer task. They were going to spend another day summarizing. Most of the percent problems involved grids: for example, to find the percent of the area shaded on a given grid, the students set up proportions such as 20/25 = ?/100. My last comment to Cathy was:

> "In the summary tomorrow - put forth a couple of problems without pictures - use pictures if some students are not ready to make the transfer. Also keep making the effort to get the students to talk about percents; that percent is a special fraction and that percent problems can be done by using equivalent fractions."

I did not see Cathy again until a week later at the pull out session for the entire group of MGMP teachers. In the debriefing part of this session each teacher reported on their transfer task. Cathy and the other teacher from her school discribed the activities and their mathematical goal and strategy for obtaining it. They then went on to report that while they usually spent 3 chapters on percents, this year they only spent a little more than a week. However, they decided to use the same test on percents that they used in the past (one that did not use 100 grids). **The classes scored above the average of past performances and there were many perfect tests even in the low groups.** Cathy was truly pleased. I think this finally made Cathy and her colleague believe in the power of understanding over memorized procedures.

Summary of Transfer Task 2

The transfer task showed great insights into what it means to understand, how to move from concrete experiences, to pictures, and then to symbols with the appropiate verbilization and activities to make the transfer among these stages of learning. Her directions and modeling in the launch phase are superb. It results in the students getting right into the explore stage knowing exactly what to do and what is expected of them. The summary stage is much improved. There is evidence of more questions asking for "why" and an attempt to get the class to make the summarizations. However, there is still a tendency for Cathy to answer her own questions and not to probe students' answers, particularly if they may not have the correct answer or the one she was expecting.

Comments from the observer's summary of the transfer task:

> "I feel this transfer task demonstrates that Cathy has grasped the essence of the LES Insructional Model and is most competent with Launch, the Explore, and least at ease with the Summary. She seems to have accepted the importance of a conceptual foundation and uses activities to provide such a foundation. She seems more capable of seeing connections between activities and concepts and produces a sense of cohesion in her lessons. She still does not seem to have a clear grasp, however, of drawing out of students the conclusions connections. It seems as though she has all the pieces and now needs a refresher course on what this is all about."

Summary of the First Year's Intervention:

The observer went into Cathy's classroom on May 28, 1986 to observe a lesson which was not related to the project to see if there was any evidence of transfer of the LES model.

The Observer's comments on a non-related MGMP lesson:

During this class Cathy introduced the protractor. She had the students examine it and tell what they saw. She had them measure angles with her and then on their own. She then asked the students to draw their own four sided figure and measure its angles. She encouraged a student who guessed at the results. She had the students practice again with her before the class ended. She told the class in the beginning that they could work in groups. In fact, when the students came in they moved the desks out of rows into groups without Cathy saying anything to them and Cathy didn't have them put the desks back in rows.

I feel that this observation does demonstrates that Cathy has accepted many of the features of the LES Instructional Model. She launched the lesson with an informal discussion about the protractor -- just getting acquainted. She demonstrated its use and had the students practice. She challenged them to draw a four-sided figure and measure its angles. They measured a four-sided figure prior to this exercise. They compared results. Cathy reinforced the correct use of the instrument before the class ended. the students were allowed to work together, in fact, encouraged to do so.

The observer's summary of the first year:

The changes over the year in Cathy's room are the difference between night and day for both teacher and students. Looking beyond the struggle for classroom management, there were improvements in presentation of content and use of the LES Model.

In the beginning of the year, the desks were in straight rows and there was no working together in the classroom. Cathy tried to hold a tight control and placed most of her energy in trying to establish rules and order. In teaching the mathematics, Cathy seemed unsure of herself and the content lacked cohesion both in the Probability Unit and in the Transfer Task.

The students were loud and uncooperative. They seemed decidedly uninterested in the content and were often obnoxious and unruly with Cathy. Assignments and exercises were used as instruments for behavior control-punishments or lessons in discipline.

The second semester observation took place in April and May. The classroom had new desks and were back in rows for the Transfer Task. However, she readily allowed the students to move into groups for class. The struggle for control and classroom management has been resolved in favor of the teacher, and yet the period of resolution had also produced a very positive, cooperative group of students. The transformation was amazing. Cathy was much more relaxed and much more focused on the content. She now discussed mathematics rather than behavior problems. She also seemed more sure of the content and projected an enthusiasm and a confidence in the concepts.

Cathy had developed an amazing rapport with the students. She now liked them and they seemed to like her. They had calmed down considerably. They were attentive, interested in the activities, willing to try the exercises, friendly, cooperative, and willing to help each other as well as be helped if necessary.

In the transformation, Cathy became more adept at using the LES Model. Her Launches and Explores became more smooth and cohesive. She gave excellent directions for the Main Challenge which allowed the students to begin immediately and complete the

activity successfully. She improved her technique for asking questions but still held a firm line on control, often answering her own questions before the students could figure out the answer. Along with this tendency, Cathy could still use some help with presenting possible extension ideas to students and with Summaries in general. Summaries became lecture times rather than periods of discovery and generalization. However, Cathy's interaction with students, drawing them out, improved greatly over the year. Perhaps most rewarding was Cathy's surprise that the students could do as well as they did. I think this helped to convince her of the merits of the LES Model.

In the end of the year interview Cindy shows considerable change in her views on teaching and learning and classroom structure from the first interview. She is more relaxed, confident and pleased that she survived the year with an observer and coach in her classroom.

The following are quotes from her interview:

Q1 What are the big ideas in seventh grade math?

"I would hope to become 'more independent in their thinking', ...starting to may be "use reference material more readily". "Be more aware of what's going on and see more relevance to math". ...In the broader sense "there is some application here and these ... I want them to know and need to know."

Q5 on student attitudes toward school and mathematics:

"I've seen such a variety this year. I've seen some very slow students who have really come on so strong and I don't know what has sparked them, but it's just like suddenly that they're turned on to at least learning math class." ..."I think they 've have come a long, long way. ..."I think they are kind of surprised at some of the things we're working today with squares and totaling degrees - ..this is our first day with protractors, ...I had them total (degrees) of the angles and then they cut the square apart and they could see then that there was two triangles and the sum of their angle measure was 180 and it was amazing how, to me, how quickly they picked up on it this year in comparison with other years. ...I think they are looking for some other ideas ...That each math class isn't a little unit by itself. But that there are some ideas .....I think they're looking for those things now."

Q6 How important is drill and practice in your math class?

"I think it's very important but I think equally important is how it's done. Again, not with pages of the drill work but to keep bringing it in in other ways, if you're doing area you could get into your whole .... , if you're doing something else your're reviewing addition, and your decimals. **...I will probably never again do all the chapters in the book, like add, subtract ... I am going to simply skip those and integrate them in later in different areas."**

Q 7 How do you know when your students understand the mathematics content they are taught?

"I guess you sense it, I don't buy their responses by the answers and whether they feel confident with what they're saying, whether they're kind of ruffing along... ...There have been times they have not done well on tests and yet I know they know more, the test just didn't get at evidently their understanding level."

Comments on teaching the Similarity Unit

Q 10 Describe any changes you had to make in your usual teaching style.

" ..perhaps more questioning about how this was happening and how we got from this point to this point."

Q 11 Comments on the content and students' learnings.

"I think the part where you square the scale factor to get the area could almost be left untouched at this point. I don't think we were ready for that last summer, it was something new... it's a difficult idea for them... maybe touch on it but certainly not expect mastery."

Q 12 When you teach Similarity next year what changes would you make?

"..probably introduce it very early in the year, do a few lessons then and then I would much rather teach things in bits, and pieces, go back and review some of that and add more to it. Then have a whole big dump at one time. ...So I would take a few lessons, probably three, possibly four and then even early in the fall just because it would be so different from the way most of these kids have done their math."

Q 13 What about the way you taught this Unit do you think will transfer to your teaching of other units?

"...the carry over into other units is fantastic. ...like in ratio and proportion, there were things you really totally skipped in the whole chapter, they really were familiar with that and simply maybe pointing out a few things" ...(Cathy is referring to the amount of learning that went on in the units - several sections and chapters in the book could be cut.)

"...I think I will always use more models. I have always used a lot of models and had them work a lot on graph paper, but I think I would be much more conscientious about doing it. Surface area, I would probably have shapes even traced on graph paper and let them cut them out, count till they figure out a different way to ..."

Q 14 concerning help during the year from the coach.

"... the first time you are not used to that constant pressure of having observers in the room and people writing down what you're doing and as you get used to it I think that becomes less of a problem. ..." "...it's also, at first embarassing to have some body acting out (in class) because you think everybody's supposed to be sitting here like model students and they're not."

... (concerning the planning and feedback sessions with the coach)..."she (coach) was able to offer so many suggestions as we were trying to plan our transfer task ...give us ideas - which way to go. It was definitely helpful to have her here."

Comments on Transfer Task 2:

Q 15-16 What content did you choose for your second trasfer task and why?

"...percents. And we simply wanted to get the idea across that the percent is a ratio out of 100 and it can be used as a proportion. We did not pursue the proportion idea that much. Our eighth grade teachers this year said they really didn't remember anything their students knew from our whole three chapters of percents that we covered last year. Which is probably a good months time of struggling because they never know what to divide by what, or multiply ... so we thought this year - well let's not even get into that. Let's just learn what a percent is."

Q 19 List and discribe any changes you made from the way you have previously taught this content.

" ..pretty much by the book....they have a page of moving the decimal point and you

know, they just close their eyes and move the decimal point. Whereas if they're doing this shading (on a 100 grid) - they really are much more into it."

Comments of LES model.

Launch: "..I'm not much for story telling. ...I almost feel like the kids are sitting back and saying I don't believe this. So my stories come in more ad lib wherever they feel appropiate. ..Just a short demonstration, on the overhead usually."

Explore: "..in a regular class that is your own kind of working time and this kind (MGMP units), this is your busiest time... because you are going around and you don't then have the time to correct papers....do anything else. So it's much more time consuming."

On the use of groups: "I don't ordinarily... However they are free to get up and move around and work together. I don't have a problem with that. But I don't like grouping, it's just too long and spread out... I think they're very advantageous but I think they can be very misused too. ...usually when I make an assignment now, when they get through I want them to go compare their answers with someone else and when they find a discrepencey go back and work it out together. I think that's very valuable for them to look for mistakes and I have no problem with that."

Summarize: " after the explore...getting back together - we did some charts to summarize such as today we did four different kinds of triangles...they measured...filled in their charts and made statements from their charts."

Q 23 As you reflect on the experiences you have had this year.....do you feel the class has changed? How do you feel about the class?..

"Yes, in my sixth hour, which is the one that was observed. **Even though some days they have been totally obnoxious, I am constantly amazed at some of their test scores and how they come through at the end, I really am."**

The Teaching Syle Inventory and Student Survey of the Classroom at the end of the first year:

The teachers repeated the Teacher Style Inventory and gave the Student Surveys at the end of the fisrt year. We calculated a level for each teacher by computing how far from the "ideal " answer each teacher fell. A similar computation was done for the student surveys.

The change in Cathy's beliefs and actions about teaching and learning are also reflected on this inventory as there was a +16 points movement toward the "ideal score". In particular, her beliefs increased in a number of items such as the value of students working together and in groups (items 4,5,10); encourages students to solve math problems in a variety of ways (item 6); emphasizes conceptual understanding a bit more than computational skill (items 11, 13); questions require more explanations, are more open ended (items 14, 20); uses more concrete manipulatives (items 25, 40).

Changes in the student surveys of Cathys classroom showed a positive gain toward the ideal score.

Coach's Summary:

Cathy has made great progress during the year on understanding and using the LES Model. She has come to value "conceptual understanding" of mathematics, what strategies are needed to accomplish these understandings - in particular the use of concrete manipulatives and activity based lessons. In her Spring 1986 interview she talks about the value of the units and transfer tasks and wishes there was more time to do such in-depth planning. She also recognizes the value of doing these kinds of activities in the elementary grades and plans with her colleague to try to work with the elementary teachers in their district. She has come to believe that not all concepts are of equal importance in mathematics and that deep understanding of a few important concepts carries over into many other areas of mathematics. She still tends to dominate the communication within the classroom. But Cathy is a person who thinks deeply and carefully about her teaching. As she continues **to teach and reflect** on the exemplary units and the transfer tasks, she will gain the confidence in herself and in the mathematics to open up her questioning techniques to allow for more "why's" and "what if's" and to capture the intended spirit of the LES Instructional Model.

III. A Disscussion of the Second Year Intervention with Coaching.

Overview of Coaching and Observations.

In the Summer of 1986 the entire group of eleven teachers together with 7 new colleague met for two weeks at a local middle school. The schedule was similar to the first summer. The first day was spent on providing an overview of the Probability and Similarity Units to the seven new teachers and an overview of the Factors and Multiples and the Mouse and Elephant Unit to the old teachers. For the remaining 9 days Lappan and Phillips taught the Probability and Similarity units to 30 seventh grade students for two hours each day while the teachers observed. Each teacher was assigned to observe one or two students during the activities and monitor what sense the student(s) was making of the mathematics. That is each teacher was to view the day's activities through the eyes of a student. In addition, discussion centered on the effect of different strategies. After the students left, the teachers engaged in a discussion of the lessons. Questioning and communication were extensively discussed. Management and mathematics content was not as important as the first summer. The experienced teachers, having just taught the units during the year, were keen to observe specific activites for motivation, questioning etc. The rest of the time was spent on developing a common transfer task for the next year. The teachers selected fractions and worked in four groups. They came together occasionaly as a whole group to talk about the LES Instructional model, concrete models for introducing fractions, etc. At the end of the two weeks each group presented their unit.

Cathy only attended the first day. She was scheduled to go to Europe for the summer. The trip was canceled at the last minute but still she only elected to attend the first day. Later in the year when she had been working with her colleaque (who had attended the summer sessseion) on the fraction unit which was their first transfer task, she

commented to me that she felt she had missed quite a bit by not being present for the entire two weeks. It was unfortunate as this was a time when the collegiality and networking was really cemented among the group . The group reflecting, discussions and planning was a large step forward for the teachers in taking ownership of the LES Instructional Model.

During the second year of intervention both the coaching and observations were scaled back. Only two activities (rather than three) were observed. I decided to be there for the first activity and then for the two observed activities ; I also decided not to give written comments but to make any relevant comments during our brief discussions after class. I wanted them to believe that I had confidence in their ability to deliver an effective lesson. Due to a schedule conflicts we did not have any of our in depth debriefing and planning sessions as we did in the first year. The teachers seemed confident in their ability to teach the units and the transfer tasks (fractions and percents) without my help. In retrospect I think I should have worked harder to have some debriefing sessions and at least one or two written reports during the year.

PROBABILITY, TRANSFER TASK I, SIMILARITY, TRANSFER TASK II.

Cathy taught the probability unit first at the end of September and beginning part of October. I am there for the first activity. She introduces me to the class and I make a few comments on why I am there. She is much more relaxed and I become a part of the class; contributing to their walk-a-thon for charity and wearing green and white on Spirit Day - the day before the Michigan State University and University of Michigan football game when everyone, including the teachers dress in the colors of their favorite team. I also pass out MSU pencils and in one of the classes one of the students discover that I am the mother of one of MSU's soccer players. I am now a celebrity. The class I observe is 5th hour and the students seem to be brighter than last year. The class is very well behaved, cheerful, cooperative and have a great deal of respect for Cathy and each other.

As in the past Cathy greets me with an excuse, "it's not going well today - it's very hot and humid and there are many interruptions for pictures etc."

Yet, Activity 1 goes very well. The desks are arranged in groups. In particular the "lottery game" is well executed. She made changes from last year which kept the pace and interest up. Her modeling before and after the drawing was a major factor in the class picking up on the unfairness of the game. In fact the table of four boys sitting next to me had been assigned numbers in the low thirties and as soon as the lottery started, one of the boys commented that "If they draw a 3 on the first draw, one of us four will be the winner - we each have a one in four chance on the second draw - the others only have a one in ten chance."

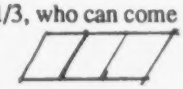
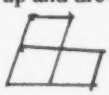
A week passes before I go out again to observe activities 6 and 7. Cathy is much more relaxed and claims even though she is teaching probability to four classes, she is not tired yet. The students are not put into groups and she misses the chance to get the students to buy into the challenge by not having them quess which arrangements would give the best chance of picking a red marble. The students are put into groups for activity 7 to simulate the one-and-one basketball game. This is a bit flat and Cathy knows this. She says after class that "she did it different in the morning and it went better, but she went back to the script for me". She said she analyzed the probabilities for

all the situations and then went back and calculated the expected values. I told her that I thought that was a good idea and encouraged her to make the unit her own.

She is much more confortable with the mathematics and the flow of activities. She encourages students to suggest ways to make the games fair. Students come to the front to separate the area to represent the probabilities. She still tends to dominate the communication and her questions do not require much in the way of "why".

The first transfer task on fractions takes place in January 1987. The unit is one her colleaque worked on for the summer. They used both circular regions and fraction bars for equivalent fractions. Then they used the bars to develop algorithms. They not only use concrete manipulatives but pictures. The kids go back and forth among concrete, pictures, number lines, and symbols. The introductory unit on part/ whole is very good and in general, even though this is taking more than a week on equivalent fractions (one section in the book), Cathy is very excited and sees the amount of understanding that the students are gaining.

The following is taken from the observer's notes, 1/15/87 :

> The students were given an exercise sheet containing several problems with a fraction and a geometric interpretation. The students were to find the whole.
>
> #8
>
> 1/3
>
> T: "If this is 1/3, who can come up and draw a whole?"
> S1. drew 
>
> T: "Are there any other ways to do this?"
> Two more students went up and drew the following models.
>
> 
>
> #12
>
> 2/3
> ....
> ....
> ....
>
> T: " What about # 12. It is the hardest of all. It starts with 12 dots. Can you find the whole?"
> S: "Find 1/3 of the whole first. That is 6 dots. Then you can find the whole."

Some of the answers the students give are very insightful. She doesn"t seeem to capitalize on them such as asking follow up questions or asking if the strategy will work on other problems.

The transfer task is a large improvement from last year with much evidence of the LES model and much planning to come up with the appropiate tasks, sequencing and student activities. She has the class in groups for this set of activities. The one weakness is perhaps the explores are not centered around a "true challenge". (This is true of all the groups last summer.) The challenges do not promote enough discovery on the part of the students.

The similarity unit is not done until May 4, 1987 and the second transfer task at the end of May. However, Cathy and her colleagues were asked to present their percent unit at a regional mathematics meetings in February. We had brief planning sessions on some suggestions for what the message of the presentation should be. It went well and they seemed to be pleased with being asked to share their knowledge. Both the similarity and transfer task on percents go much better than last year. But perhaps Cathy is too relaxed. Sometimes the enthusiasm is not quite there. However, she mentions in an interview last year that she is not good with stories, but the spirit is not quite there. The tic-tac-toe is not one of suspense and discovery as she gives the students the numbers for the axes. This game was much better last year with a real sense of discovery. It is late in the year and the pressure of not having me in the room may be showing. She is definitely more confident of the material and in the flow of the activites. Her knowledge of the scale factor is much sounder. She doesn't go for mastery on the first try, but is content to let the concept develop naturally in later activities. Her summaries consist of many questions, but they usually require either a number, answer, criterion for similarity or how to do a certain procedure. There are not many why's or extensions.

She felt her students showed more improvement on the pre and post tests for both units than her classes last year. Our student test scores show that in both years the students did quite well and the gains were about the same, but she may be using the quality of discussions and her own confidence as part of this evaluation.

SUMMARY OF THE TWO YEAR INTERVENTION:

The effect of the two year program on Cathy can be seen in both her Teacher Style Inventory and the Student Surveys which were administered three times during the intervention. The results are:

	Spring 1985	Spring 1986	Spring 1987	Change
Student Survey of the Classroom:	27.02	23.42	24.11	+2.91
Teaching Style Inventory:	48	32	37	+11

Cathy started out closer to the ideal score in the Teaching Style Inventory than any other teacher in the original group and still her improvement was substantial. Overall there was an improvement on both instruments from the Spring

of 1985 to Spring 1987, but that there was an actual drop from Spring 1986 to Spring 1987. Some possible explanations for this might be that she was overly anxious to please me and answered what she thought we wanted or during the final year of intervention she had a chance to reflect more and was more sure of herself and on what parts of the program she valued the most. Missing the second summer followed by the less intensive coaching may have contributed to the adjustment of the final scores.

The Teaching Style Inventory: pre, interim and post with evidence from the last interview (5/87):

Examaning the Teaching Inventory we find Cathy moved in a positive direction the first year and then reversed the second year on items 5, 8, 12, 18, 20, 22:

She moved in a linearly positive directions on items 4, 6, 10, 11, 13, 14, 21, 25, 26:

She either remainded constant or changed slightly in a negative directions on the other items.

The LES model: grouping and whole class instruction:

In item 5 she changes her mind about the use of allowing students to work in groups. This is somewhat misleading since she does allow and encourages students to work together on homework etc.

From her last interview in the Spring of 1987 she says:

> I: "..so when you think about teaching your units, (MGMP units), what kind of changes did it make in your regular teaching style?"
> C: "The first one I think would be the grouping. I just do not like my students in groups, I cope with it when we do probability and similarity. A few other chapters and areas we have covered we have worked in groups. I am more comfortable with them working in rows and giving them permission to go work with each other, so that any given day they might turn their desks and work with somebody else, or go sit by somebody else, but I do not like them sitting in groups of four or six. For me I quess I like the structures of the rows. For the instruction time and when they are working on some of their material, fine. So that was one big change I had to make, was accepting them in groups, and allowing more time exploring. I'm sure I allow more time now for them to work with each other after I have done some instruction kinds of things and I might go back here and have 4 or 5 kids come around me if they're having trouble, so there's more of that kind of thing."
>
> I: "What about the way you taught the units this year- do you think has transferred to your teaching of any other math content that you would teach?"
> C: " Some of the grouping that I do and more of the exploring and even when I'm using my overhead I might try to - rather than just surface area I would cut the surface out of graph paper and have a transparency so they could see rather than just talk about the squares they could see the squares , that kind of thing."

I: "...What are your plans for next year?"
C: "Probably try to incorporate more of these ideas into the way I am teaching, most of the areas, probably not have that much more grouping. I would group for the probability and similarity just so they would have their experience, but I prefer the way I group which is in rows and then small groups that can fluctuate from day to day."

Later

C: "I think if your program goes on, the teachers getting involved should be more aware of the involvement. I don't think I had any idea of the time I would be spending on it when I first went into it."

As I read these comments in juxtaposition to each other it occured to me that Cathy may think we want students in groups for entire lessons. That was not necessarily our intent; we put students into groups in the summer for the entire time - we had 3 or 4 students to a table. But the explore part of the LES model is the only part that is necessary to have groups. Most teachers find it more convenient to leave them in groups for the entire unit. Still I think she misses the true intent of the group work in the explore; that is, having students work together on a challenge, share or construct strategies and conclusions. She does not comment on the Launch or Summary.

However, there is evidence that she values grouping on the Teaching Style Inventory:

In item 4 she went from a strongly agreeing with "students frequently work together on assignments" to a very strong agreement with this item in the end. On item 10 she went from a strong areement with "the furniture arrangement is the same for every math lesson" to on the post strongly agreeing with "the furniture arrangement varies according to the lesson". In item 18 she went from very frequently using the "whole class instruction" as a strategy to frequently and then back to very frequently. Also in item 35 she when asked what percent of the homework assignment is completed in class by most of the students and what percent is begun in class but finished at home , she went from 80% to 50% on the first and 19% to 49% for the latter.

This might be interpreted as more time in class is spent on group-type activites and discussions rather than homework sheets of drill and practice, possibly reflecting the LES instructional model of the MGMP units.

Finally, she claims the units are too long to do in one stretch.

C: "I would rather do probability and similarity closer together and then maybe at the end of the year go back and review some of these ideas." ..."In both of these units I would really love to see them introduced in 6th grade - the first four activities and then pick up from that and ...do a quick review in 7th grade and extend the units. I think it would be much more beneficial."..."I think they (students) get tired of this kind of learning too, expecially to start with because they're not used to it at all, and they are more comfortable with an assignment, a grade, they know where they're going, and their parents are in many cases more comfortable with that. So there's a whole new ball game here, that you have to educate the kids into working this way."

Using concrete manipulatives:

In item 25 on the use of concrete manipulaives she goes from seldom, sometimes, to frequently. For item 40 on the pre MGMP she lists compass, protractor, ruler, and

caculator as her manipulatives and on the post-MGMP in additon to these she adds solids, cans, boxes, models.

This is supported in her comments from the last interview:

I: "..How well do you think it went (transfer task on fractions)?"
C: "Very well. I would like to start that even earlier in the year. The kids enjoyed making their fraction bars. I think if we did it again rather than have them try to fold it we would actually have them marked out, because as they got to the smaller ones it was very difficult to have them fold like the 9th or 12ths and then try to have them compare that to the 4ths because just in the folding the construction paper, the folds would use up some of the material, so none of it worked out quite the way it was supposed to. .... they did a good job on it, but none of us can fold construction paper six times and get good sharp creases.

I: "When you think about the two Transfer Tasks that you did this year, what kind of changes did you make in the way you previously taught the units, say 3 years ago?"
C: "With the fractions I think before I simply assumed they knew what fractions were. We didn't try to draw fractions. If I taught 1 3/4, I assumed they knew what that was. So I spent a tremendous amount of time developing the idea of a fraction this year compared to what I had done other years, equivalent fractions, the same way, using the fractions bars, so there was much more hands on for them and that basic understanding of fractions. When we got to the adding, subtracting, multiplying, dividing , we went back to the book and did more of the way I've always done it.

Views on conceptual understanding and problem solving:

In item 6 she moves in a positive direction from "I encourage students to solve a given math problem the way I have demonstrated." toward " I encourage students to solve math problems in a variety of ways."

In item 11 she also moved in a positive direction from "In my math class I emphasize the basic computational skills three/fourths of the time or more." toward "In my math class I emphasize concept development three/fourths of the time."

In item 13 she moves in a positive direction from "Understanding the rule or procedure is not critical" toward "Understanding why a given rule or procedure gives the correct answer is important."

In item 14 she moves in a positive direction from "Almost all my answers can be answered with yes, no, or a number." toward "Almost all my questions in math class require the students to give explanations."

In the above four items she started in the middle and went one step toward the positve directions.

Items 20, 21, and 22 cover the use of instructional strategies. In item 20 (Posing open-ended challenges) she went from sometimes, very frequently, and finally to frequently. In item 21 (Gathering and organizing student responses) she goes from seldom to frequently. In Item 22 (Encouraging analysis and generalization) she went from sometimes to frequently and back to sometimes.

During the two year intervention Cathy's awareness of conceptual understanding and its role in the curriculum increased. This is supported in the following comments from the May 1987 interview:

I: "What are the bit ideas in 7th grade math?"

C: "I'd like to see kids being able to utilize some of the skills they've used and apply them more rather than just rote learning - I would say applications."

I: "Compare the level of functioning and potential capability of your mathematics students in the following categories: memory, skills, concepts, problem solving, applications, generalizations."
C: "I think it's closer, I think they are closer to their capability but I think they're all still below, and especially in being able to generalize and do the application. They are just so used to wanting to do a whole page of adding and then needing more instruction to be able to apply that maybe some place else."

I: "How important is drill and practice?"
C: "Depends on the concepts that we're covering. We're doing surface area right now and we're going to do - if you want to call it drill - we're just going to do a lot of problems and take the thing (solid) apart and see the sides. As far as sitting down with a drill sheet of adding, no, but if you're talking about doing several or many problem of a certain variety, yes in certain instances. I think they need that reinforcement."

She seems to confuse spending a lot of time on conceptual understanding of surface area with practice finding surface with giving the students the formula and lists of problems to finish with no motivation for where the formula came from.

I: "On the (first) Transfer Task what content did you choose for your first Transfer Task?"
C: "Fractions."
I: "Why?"
C: "They don't seem to remember any of this material they have learned in the 4th, 5th, and 6th grade, and we are very concerned about the time we have to spend going over things that originally assumed they knew. We have found out that they really don't know much about fractions at all."
I: "They don't have much of an understanding?"
C: "No. Absolutely very little understanding of what a fraction is and what it constitutes and what makes up a fraction."
I: "What was your goal for the Transfer Task?"
C: "To have them have a good understanding of a fraction - how a part relates to a whole."
I: "..when you get to the computational kind of thing with fractions, once you felt they had the understanding of what the concept was all about, then they could also go back.."
C "If we were adding mixed munbers 2 5/6 and a 1 3/4, we might get the 3/4 and the 5/6 and put those together so they know it has to be more than one - a few examples like that.

I: "How do you know when your students understand the mathematics content?"
C: "They retain it for a much longer period of time, and they can talk more knowledgeably about it and are more comfortable discussing it."

I: "What motivates your students to learn content?"
C: I would think for those that care, the grades and their own personal success - the desire too know."
I: "Has that changed across the year in your class?"
C: "I can think of a few students that might have changed where if they had a D to start with and realize that they're capable of doing A work - I have one boy who went from a D the first marking period to an A and that's quite a change for him and he wants success now. I think, too, we have a tremendous range in our 6th grade classes as far as what the teachers are teaching. Some of them don't like to teach math and so some are coming in with very little background from even 4th, 5th, and 6th grade classes as far as what the teachers are teaching, and once they can get going they can really start flying. So there are

a lot of different causes that I think would apply."

C: "Again we're dealing with 160 kids and I think most of them enjoy coming to school whether it's for friends or classes or whatever it is, and most of them cooperate pretty readily, but you always have some that don"t"
I: "So it's not that you have a lot that really hate mathematics?"
C: "Oh, no, I think most of them enjoy coming to class."

Planning and Reflecting:

We don't have any information on the kinds of reflection and planning that Cathy was involved in prior to the MGMP. However, there is evidence in her interviews that she was able to reflect on both the transfer tasks and suggest changes for next year. Some of this occurred in her discussion of fractions (quoted earlier in the summary). The following comments further exemplify her ability to reflect on her teaching and students' learning:

I: "What about your second Transfer Task? What content did you choose?"
C: "The percent unit that we did last year."
I: "Why did you choose it?"
C: ""Well we felt that the 7th graders really didn't learn much from the whole month we spent on percents when they got to the 8th grade. I asked an 8th grade teacher this year if she could tell any difference because we had only used a percent unit for about 3 days last year and she didn't really see that they knew any more or any less than they had if we spent a whole month on it."
I: "Great. So did you want to make it a little bit longer this year?"
C: "Next year I will definitely make it longer and do more application and I'm sure I'll use the grid. I like the end of our percent unit where we shade in percents, where they are figuring out the part of 100 and then changing that into the other percent. So I will extend that and do some story problems in there and probably try to extend that quite a bit."

I: "...Suppose we were all going to do a Transfer Task on decimals what would be the first thing that you'd think about?"
C: "What they are thinking a decimal means to start with, and then I would try to get the idea across maybe similar to fractions that it is a part of a whole thing, and get some of that equivalency in there to 100th and 10th. So that the decimal itself has more of a meaning and they realize they're dealing with a fraction."
I: "And what kind of materials would you think about looking at?"
C: "I guess I would start looking for some of the resource materials available, If I can't find something, see what I could come up with . I'd have to sit and ponder a bit. I would love to do a unit on graphing, getting into more of the statistics. I think the kids need to know how to read visuals.

I: "What was most helpful to you in terms of planning for and teaching the units in the transfer tasks?"
C: "Oh I would think (the coach) helping us get some of the materials organized and keeping us on track with where we were going with it."
I: "Was that (coach's feedback) different this year than it was from last year?"
C: "No, of course there wasn't as much this year because she wasn't here as much. She just was really very helpful in critiquing some of the things you do and giving you guidelines or suggestions for a way you might do it the next time.
I: "What about being observed because I'm in charge of the observers?"
C: "Oh, I don't mind it so much now. I don't like the tape recorder going when I'm having class. It gets me more uptight than having two people sit there."

Leadership:

Cathy realizes the need to coordinate the curriculum across several grades and she refers several times about wanting to help the elementary teachers. She does not talk much about the higher grades; perhaps it is because she was once an elementary teacher and feels more comfortable working with these teachers. She also suggest that more units like the MGMP units be written for elementary teachers.

> C: "There is such a lack of basics in the students we're seeing that I would really try to get some units into elementary school and stress to those teachers that they don't maybe need to follow their textbooks quite so closely."

Postscript: She and her colleague have presented workshops on their percent units. Since the end of the project they have been working with the elementary teachers in their district. Cathy has talked with me about the possibility of doing consultant work. She has also incorporated two more of the MGMP units into her classes.

Cathy cites the following characteristics as ones she wants to see in her students:

> "Enthusiasm and a desire to learn about math, and I don't care that they're so especially bright with it but if we can keep them enthusiastic about what we're doing and turned on to what we're doing I think they'll learn a great deal more."
>
> In her survey concerning the statement: "My basic function as a math teacher is to convey my knowledge of math to the students in a direct manner." she went from a strongly disagree, to a strong agree, and finally back to a somewhat disagree.

Later in the interview:

> "I try to work on manners, incidentally. I like them to have a concern for others. If somebody's out for an extended illness we might send a card, and take the time out in math to just sign it, and just be aware of others feelings, and I think 7th graders need to start being a little more aware of their potential for hurting other people, and I think it can be a real problem for junior kids, dealing with all these changes. So we don't stress it but it's always there."
>
> "I feel I've been hired to teach math and maybe that should be my number one priority. I am sure down deep I don't feel it is, but how I deal with these kids for me is going to be number one."

Cathy started the program as a very good teacher, one of the best in the original group. She also views herself as being an effective teacher. Throughout the project she struggled with the pressure of teaching two new units and having to create and teach two transfer tasks. This involved a change in her usual teaching style and a change in her views on conceptual learning in math. Often times she became frusted and exhausted trying to do this for 6 different classes. The frustration and fatigue maybe because she wanted so much to be perfect. That is what she thought we expected or perhaps she expected it of herself. She is a deep thinker and a very caring human being. During the second year she became more comfortable about the project and how she was going to teach the units. A deeper understanding of the units and the LES model of instruction may have been gained had she been able to attend the

second summer workshop or if I had pursued a more intensive coaching role the second year. It was also during the summer that many of teachers acquired the lanquage needed to talk about the model and student learnings. The one area I wish I had been able to help change is for her to take more risks in her communications with the students - in particular to use more open-ended challenges, more asking " why" , and extending students' strategies or persisting longer with wrong responses. She has gained a deep , and I think lasting, understanding of what it means to teach for conceptual understanding. I don't think she will ever be content to just teach the book's three chapters on percent or that she will assume her students understand fractions. She has also begun to extend this kind of thinking and planning into geometry, measurement, and statistics. Furthermore, she is willing and anxious to share her experiences with other teachers, and take a more active professional role in mathematics education. There is one thing that Cathy brought to the project, which we had no influence over, and which many teachers never achieve, and that is her ability to make every student in her class feel important; the respect and caring on her part and on the students' part is genuine. A certain kind of happiness - the kind that comes from contentment with feeling good about yourselve permeates the room.

Appendix D

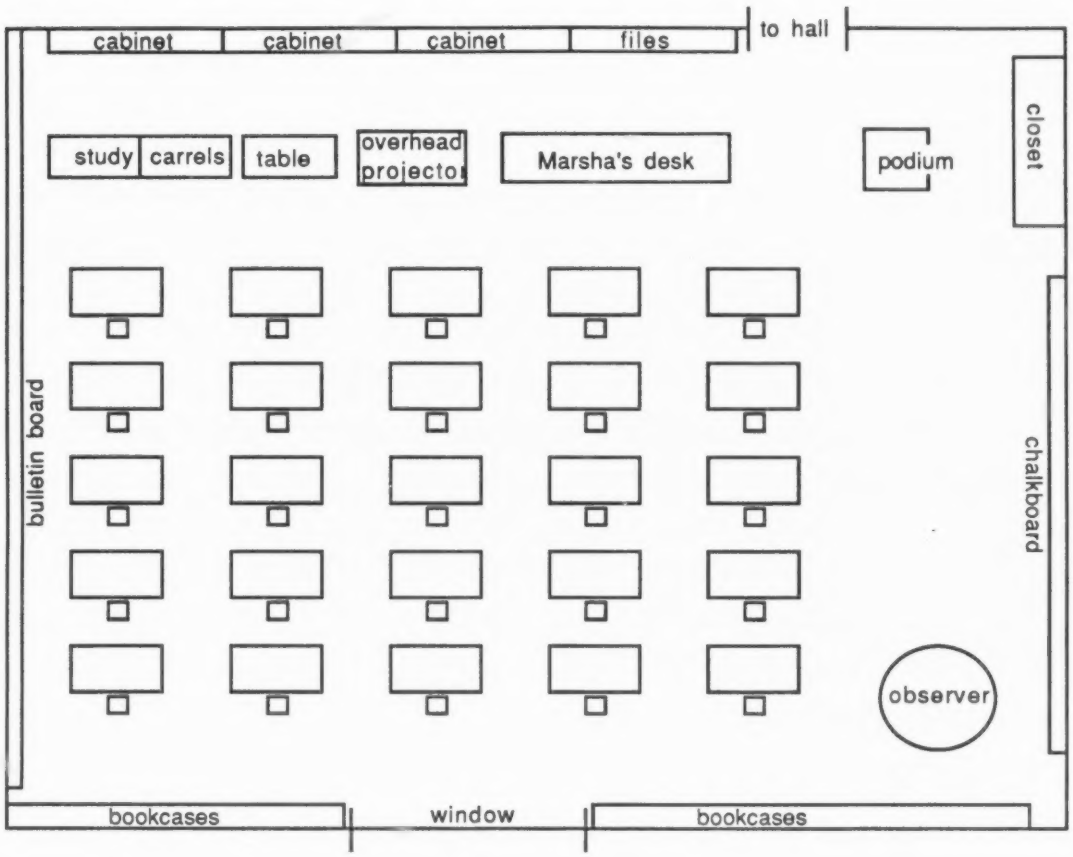
Marsha Wilson: An Uncoached Teacher

This is a case study of Marsha Wilson, one of the Middle Grades Mathematics Project's uncoached teachers. The report is separated into four sections: I.) A portrait of Marsha Wilson's classroom instruction prior to the MGMP's intervention activities; II.) A summary of her instruction of the MGMP Probability Unit and one Transfer Task during the first intervention year; III.) A summary of her instruction of the MGMP Probability Unit and one Transfer Task during the final intervention year; and IV.) A discussion of the changes in Marsha Wilson's mathematics instruction across the project. Marsha taught the MGMP Similarity Unit in her classes for two years and implemented three other Transfer Tasks, however, these will not be discussed in this document for two reasons: First, her instructional mode did not change significantly from Unit to Unit or Transfer Task 1 to Transfer Task 2 across each year; and, the data used for this case study was selected because it represented her typical instructional mode during each period. The inclusion in this case study of all the observational, interview, and psychometric data gathered on Marsha and her classes would result in a case study of unreasonable length.

I. Marsha Wilson's Classroom Instruction Prior to the MGMP Project Intervention

Marsha Wilson had been teaching middle school mathematics for 22 years when she joined the Middle Grades Mathematics Project. She has both a Bachelor's and a Master's Degree in Mathematics Education. Her school, Arborville Middle School is situated about 40 miles southwest of Michigan State University in a rural/small town district. Most of the families of the 750 students attending the school are from the lower-middle class to the middle-middle class--and most are caucasian. Marsha's classroom contains 25 individual student desks arranged in five rows. During a math lesson Marsha might have the students focus their attention on the overhead projector screen and then slightly turn their desks and continue the lesson at the chalkboard. This seating arrangement permitted this to occur with a simple 90^{o} turn to the right. The following is a diagram of her classroom:

Marsha Wilson's Classroom



The classroom contains several cabinets holding a variety of manipulatives, supplies and games. There are cardboard boxes under the study carrels in which more supplies are stored. The overhead projector sits on a table facing the front of the room next to Marsha's desk. A podium is placed at the front of the room near the hallway door. This is used by Marsha for taking attendance and making announcements at the start of the class and for checking assignments at the end of the class period. The bulletin board is used for mathematics posters and student papers. The chalkboard at the side of the class is used by Marsha along with the overhead projector and contains a large grid for graphing activities. To the first time observer this classroom appears to be an environment that would provide students with many opportunities for the students to become actively engaged in learning mathematics.

Marsha Wilson taught one seventh grade mathematics class and four eighth grade classes (pre-algebra and general) during the first year she was observed. During the second and third years of her participation in the project she was assigned two classes of advanced sixth grade students, two advanced classes of seventh grade students and a class containing eighth grade students who had difficulties learning math. The classes selected for the project's direct observations were the sixth grade advanced math classes. During the first year, her seventh grade class was observed. In general, the students in Marsha's classes were well-mannered, orderly, and complied with Marsha's requests. When asked what motivated her students to learn mathematics Marsha replied,

> "Sometimes the teacher's approach. If she likes what she is doing, then the children are going to see it. If it is not too boring, math can tend to get boring --that turns children off. A positive atmosphere, where it is fun to be in math class, not where somebody is hollering at you because you're not doing something right. I think if you can remove the fear of failure you tend to motivate the child more."
>
> (1/8/86)

In the interviews conducted with Marsha throughout the project she expressed a concern for the emotional and academic well-being of her students. Classroom observations portrayed Marsha as a soft-spoken, pleasant and reserved teacher who did not raise her voice to the students. The rapport between students and teacher as recorded in the classroom observations was one of mutual respect and liking.

The flow of classroom activity in Marsha's seventh grade mathematics class varied from day to day depending on the mathematical objective and task. For example, when Marsha introduced a unit on geometry most of an entire math period was spent in a consideration of the characteristics of shapes and their definitions. The students took notes from the overhead projector which they kept in their notebooks. On another day the students spent most of the class period watching a filmstrip on the metric system. On a third day the students worked together in small groups on different metric activities.

In spite of the differences in the classroom activities, some common routines had been established in the class. For example, Marsha began every math class by taking attendance from the podium at the front of the room and asking the students to identify those classmates who were absent. This was followed by a brief description of the math lesson for the day. The description frequently included a statement about the tasks the students would work. During the direct instruction portion of each lesson Marsha required the students to copy notes, diagrams, and drawings in their math notebooks. These notes were collected, scored and returned to the students. Finally, when the students were given their assignment they were expected to spend the rest of the class period working on it. They usually finished early, but when they didn't they worked on their task until they were dismissed. At the end of each period Marsha stood by the classroom door and collected the daily work from the students as they left.

Marsha's instructional mode included a period of about 10 to 15 minutes of direct instruction with the remainder of the time given to the lesson assignment or checking the work. Direct instruction was teacher-led with students copying notes from the overhead or chalkboard. During the lesson assignment period the students either worked together or alone on a math task. Marsha monitored the students as they worked, however, this activity was primarily to keep students on task instead of checking for their understanding of the concepts or ideas or challenging their thinking about the mathematics in the task. At the conclusion of the period (usually with five minutes left) the students checked their daily assignment and resolved any problems they might have had with the daily task. After the assignments were checked Marsha usually gave the students a preview of the next day's lesson.

During the direct instruction portion of the lesson Marsha's attempted to engage the students in mathematical discussions or dialogues, however, in most instances direct instruction was best characterized by Marsha presenting the students with information

or demonstrating a mathematical procedure. While she encouraged students to respond to her questions, she usually settled for single-word answers and did not require more complete explanations. The students were at times encouraged to offer their opinions during the direct instruction period, however this was not frequently observed. The following selection from the set of observations of Marsha's class prior to the MGMP intervention illustrates the typical pattern of communication between students and the teacher.

> 8:14
> Ms. Wilson has a filmstrip on the metric system for the students to watch today. This will serve as an introduction to a unit on the metric system. She tells them, "We are going to do meters, liters, and grams today. This film strip is all about the metric system and where it came from. We will learn how to measure volume like you did yesterday, but we'll do it in the metric system." Ms. Wilson shows the filmstrip.
>
> 8:30
> The filmstrip has ended and Ms. Wilson begins the lesson by questioning the students.
>
> Ms. Wilson, "Where did our standard of measure come from?"
> A student responds, "France."
> Several students say, "Great Britain."
> Ms. Wilson, "How did they do it? Did they just pick up a stick? What did they do?"
> The students tell her, "They used a foot."
> Ms. Wilson, "Right. The measure of the King's foot. What did they do when they wanted to buy a yard of cloth in Great Britain?"
> A student tells her, "You would measure the length of your arm."
>
> Ms. Wilson asks a girl in the classroom to stand up and hold her arm up. She does so. Ms. Wilson also holds her arm up next to the girls arm to compare their lengths.
> She asks the students, "So, whose store would you go to get a yard of cloth? Her store or mine?
> The students tell her, "Your store because you would get more."
>
> Ms. Wilson asks, "How did they get the metric system?"
> A student tells her, "They measured from the north pole to the equator."
> Another student says, "They call them by some Greek names."
> Ms. Wilson ignores this comment and continues her line of questioning, "Was the measurement very accurate?"
> A student tells her, "No."
> Ms. Wilson, "Why?"
> A student, "Because it kept moving."
> Ms. Wilson, "What did they do then?"
> A student, "They used the sun, -- no a light ray."
> Another student, "They used a ray."
> Ms. Wilson, "They used a light wave. A light wave from a certain element."

The patterns of interaction in Marsha's classroom across the set of observations remained fairly consistent. She asked the students questions that related to the mathematical content of the lessons and expected to get certain answers from them . Students who initiated unexpected questions received either minimal or no response from Marsha.

Marsha completed a Teaching Style Inventory (Survey) prior to her work in the Middle Grades Mathematics Project. Two of the items related to the nature of the communication patterns the teacher believed were typical of her classroom instruction. Marsha responded to the items as follows:

2. When students have trouble, I ask them leading questions	_____1
	_____2
	__X__3
	_____4
When student have trouble, I explain how to do it	_____5

and,

14. Almost all my questions in math class can be answered with a yes, no, or a number.	_____1
	_____2
	__X__3
Almost all my questions in math class require the students to give explanations.	_____4
	_____5

Marsha's responses on these items were reflected in her classroom practice as observed in the observations.

Marsha used a variety of strategies to organize the students and the lessons. Students were allowed to select their partners or groups for acitivities that required collaboration. She did not hesitate to move students to other desks who were not paying attention during the lesson or who were not working well with their groups. Marsha kept a chart near the front of the room on which she had the names of student helpers for the week. These helpers were given the tasks of handing back corrected papers to

students, passing out materials and worksheets, collecting assignments, and making any needed trips to the school office for supplies. There were times during the observations when Marsha did not have the necessary materials ready, however, this was not a continuous problem. The following is an observation of a day in which Marsha's students worked in groups on separate tasks. At the start of the class she tells the students what they are expected to do.

> 8:13
> Ms. Wilson says, "Today we are going to do a lab. I am going to give each group a deck of cards, and each group will have to choose which cards in the deck they want to work on. We will be doing the outside activities tomorrow. I have a box here in the front of the room with metric shapes in it, and here is a box with graph paper and here are a lot of boxes that are marked with whatever is inside. If your project on the card calls for a certain kind of material you can come up here and get what you need. There are compasses, protractors, string, and construction paper in the cabinets by the door."
>
> She continues as the students listen, "We are going to be working in groups today. I would like you to work in groups of 2 or 3. You can work alone if you wish. You will be answering eight questions for each of the activities you do on this sheet." Ms. Wilson holds up a half sheet of paper with 8 general questions on it and reviews possible answers to the questions.
>
> All the students are paying attention to Ms. Wilson.
>
> 8:18
> She continues, "I would like to have a sheet from everybody who works on the activity, not just one from each group. Each activity has a number on it and a name." She holds up an activity card and points to the number and name. She tells the students, "Would you group your chairs into groups now."
>
> The students quickly start forming their working groups as Ms. Wilson hands out the deck of cards to each group.

The teacher's directions were understood and quickly followed by the students. For the remainder of the period Ms. Wilson circulated about the room helping groups with materials or answering their questions. The students assumed a great deal of responsibility for organizing the lesson.

The Teaching Style Inventory contained two items which related to the teacher's perceptions of how she organized her instruction and the students. These two items and Marsha's responses are:

4. In class, students frequently work together on assignments.	_____1 _____2 __X__3
Students seldom work together on assignments in class.	_____4 _____5

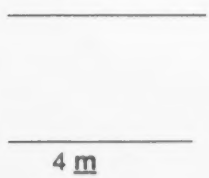
and,

10. The furniture arrangement is the same for every math lesson.	_____1 _____2 _____3
The furniture arrangement varies according to the lesson.	__X__4 _____5

Marsha's responses on these items were confirmed by the classroom observations prior to the MGMP's intervention. She grouped the students for about half the assignments and she changed the furniture arrangement according to the lesson.

The content and tasks that were observed in Marsha's seventh grade mathematics class were conceptually and algorithmically oriented. While Marsha valued her students understanding of the mathematical concepts or ideas, evidence from the observations indicated her approach was more one of telling the students some rules or patterns for finding answers to their math problems. The following example illustrates Marsha's algorithmic approach to the problem of naming the area of the following rectangle.

Ms. Wilson tells the students, "We have a rectangle like this, and we are to find a name for the area."



She continues, "We have a 4 by 3 and an m by m --and 3 times 4 and m times m is how many? How many m's do you have there?"
The students respond in unison, "Two."
Ms. Wilson, "So, what you have is like 3 times 3 is what?"
The students respnd, "Nine."
Ms. Wilson, "So, that's like 3 to the second power, and so m times m would be what?"
The students, "m-squared."

In this observation segment, which was typical of her mode of direct instruction, Marsha seemed more interested in having the students see how the corrrect answer could be obtained than in having them understand the problem or the mathematical concept.

Eight Teaching Style Inventory items related to the teacher's perceptions of the mathematical content and tasks. These items and Masha's responses to them are included below. Observations in Marsha's classroom prior to the MGMP intervention reflected Marsha's responses to the survey items below.

6. I encourage students to solve a given math problem the way I have demonstrated.	__X__1
	_____2
	_____3
I encourage students to solve math problems in a variety of ways.	_____4
	_____5
7. I present a math concept first then illustrate that concept by working several problems (deductive).	_____1
	__X__2
	_____3
I present the class with a series of similar problems, then together we develop concepts and methods of solving the problems (inductive).	_____4
	_____5
9. When I teach a new topic, I spend a good deal of the time (1/3) trying to teach students to use similarities and differences between new and previously learned math ideas.	_____1
	__X__2
	_____3
	_____4
New topics are generally taught with limited reference to previously learned math ideas.	_____5
11. In my math class I emphasize the basic computational skills three-fourths of the time or more.	_____1
	_____2
	__X__3
In my math class I emphasize concept development three-fourths of the time or more.	_____4
	_____5

12. I seldom change my approach throughout the semester (such as lecture-discussion, discovery, etc.)	_____1 _____2 _____3
I change my approach frequently (from discovery to direct telling or from another method to something different) throughout the semester.	__X__4 _____5
13. Understanding why a given rule or procedure gives the correct answer is important.	_____1 _____2 __X__3 _____4
Understanding the rule or procedure is not critical.	_____5
16. I usually use a game, story, or challenging problem to provide a context for a new math unit.	_____1 _____2 _____3
I usually do not use use a game, story, or challenging problem to provide a context for a new math unit.	__X__4 _____5
17. I usually start a new math unit by giving examples and showing students how to work them.	_____1 __X__2 _____3
I usually do not start a new math unit by giving examples and showing students how to work them.	_____4 _____5

While Marsha tried about half the time to emphasize mathematical concepts, her thoughts about mathematical instruction emphasized demonstration or procedural modes which would be more representative of computationally orientated instruction.

In summary, after observing her classroom instruction and several informal discussions prior to her involvement in MGMP intervention activities, it appeared to me that Marsha was a very good middle school mathematics teacher. Her knowledge and enjoyment of mathematics was communicated to her students in the presentation and tasks of each lesson that was observed. Her respect and liking for all students and expectation for their math achievement and positive attitudes towards mathematics was conveyed in the communication which occurred in the class as well as in informal discussions.

II. Middle Grades Mathematics Project: The First Intervention Year

This section of the case study of Marsha Wilson summarizes her project-related activities during the first semester of the first year of the MGMP intervention. It includes an overview of this period, a summary of the MGMP Probability Unit, a summary of the first Transfer Task, and a conclusion which considers Marsha's implementation of the LES Instructional Model. The Similarity Unit and second Transfer Task which took place during the second semester will not be discussed because these project-related activities did not have anymore change Marsha's instruction than what had already been accomplished by the first semester's project-related activities.

Overview:

During the summer Marsha participated in the two-week MGMP workshop/training session. At this time she 1) listened to an overview of the Probability and Similarity units that would be taught to two groups of seventh and eighth grade students; 2) observed the teaching of these units in a classroom setting; 3) participated in the discussion and feedback sessions after the daily instruction; and 4) read some of the readings distributed during the workshop. Marsha thought the overview of the MGMP units on the first day of the workshop was very helpful because as she watched the students she thought about how she would teach the same unit in the fall. She liked observing the teaching of the units to a class of students. Commenting on this she said,

> "I think that was great--observing the teaching of the unit with the students. I think that is really necessary. But I think as observers we needed to know what to look for. I think when the observers know what to look for they would know how to do the discussion, which would have been more meaningful to me than it was."
>
> (1/8/86)

With respect to the discussion and feedback sessions after the daily instruction, Marsha didn't think they helped her to become smarter about teaching the MGMP units she observed. Her reaction to the discussion and feedback session was,

> "I didn't know what to look for and I didn't know what to discuss. Sometimes I thought we discussed things that were irrelevant."
>
> (1/8/86)

Marsha didn't think the readings selected for the teachers were very helpful to her. Her reactions to the readings included the need for them to have more structure,

> "They didn't help me a lot. I think there should be a little more direction (from the staff) to them. I felt they were handed to me as something extra to do. If we could incorporate them into what we would be doing they might have been more meaningful.
>
> If I knew the purpose for reading them, like if they were for my own entertainment or for something that might add to my skills, then I would have been more inclined to read them. The way I read is when I have a reason for reading."
>
> (1/8/86)

Marsha Wilson's classroom had not changed since the observations made in the previous spring. The students in the class selected as the project's target class were advanced sixth graders who left their self-contained classrooms once a day to attend Marsha's math class. Marsha worked with them this year to prepare them for a special pre-algebra class she would teach in the seventh grade. The students are above average in intelligence, very inquisitive, and eager to learn. They are a closely knit group of children who work together very well. The only difference in the classroom routines was this year Marsha provided the students with math folders they kept in the room. She said she borrowed this idea from the MGMP Summer Workshop session and found it worked out quite well as a way to help her better organize the materials and papers for the class.

Teaching the MGMP Probability Unit:

Marsha completed activities 1 through 5 by mid October. She stopped the unit at this point to work a few days with the students on statistics. She gave them a list of vocabulary words they discussed and had some activities where they collected

and analyzed data. Marsha noted the students easily understood the ideas of the first five activities in Probability Unit and thought that activities 6 through 8 would go quickly (according to her each activity would likely take one day). She said she cut out some games and parts of activities that seemed repetitious for the students, she felt they did not need to do all the activities in order to understand the ideas that were being represented. After observing activities 6 through 8 I felt the students knew what they were expected to do for each task, however I was not convinced they undertood why they were doing the activity. I don't think they fully grasped the concepts underlying the activity.

During the LAUNCHES for activities 6 through 8 Marsha followed the script too mechanically as she set the contexts for the activities. She appeared very uncomfortable when teaching the activities which gave the impression she lacked enthusiasm for either the activity or the underlying mathematics. Although she involved students in the launches by questioning strategies, they continued to have the lecture-demonstration orientation which typified her instruction prior to the project's intervention. The launch from the observation of Activity 6 characterizes Marsha's instructional patterns in the Probability Unit.

> 9:00
> Ms. Wilson tells the students, "All right, today we are going to have a story about a princess, a dragon, and a peasant. The princess is falling in love with the peasant. Her dad, the king, doesn't want her to marry the peasant, he wants her to marry a prince. They have a big argument and the king finally says, 'I will put you in a room in the back of the dungeon, and if your peasant can find you-you can marry him. If he can't find you there will be a dragon there.' Now class, which room would you choose to be in?"
>
> (insert reduced copy of maze 1 Act. 6 <u>without grid</u>)
>
> The students say, "B."
> Ms. Wilson, "Why?"

A student tells her, "Because there are more ways to get in to **B**."
Ms. Wilson, "Would anyone choose a different room?"
Nobody responds.

9:05
Ms. Wilson, "Let's analyze the situation. Here we have a grid and that can help us make our choices." She has a 6 by 6 grid on the overhead projector.

(insert grid on Maze 1 Act. 6)

Ms. Wilson continues, "On this grid he has three choices. He could go here, here, or here. If he chooses the top choice or the top path, what would he do?"
A student says, "He has two choices left."
Ms. Wilson, "If we had a dice game we would roll the dice -- it is like dungeons and dragons. What could you do?"

9:06
All the students are paying attention and following the teacher.

Ms. Wilson, "We can divide it in half and put our **A** here and our **B** here. Now in the middle choice, where can he go?
The students, "All in **B**."
Ms. Wilson, "Right. Now, the bottom half--where can he go?"
A student, "Well, one path goes into **B** and two paths go into **A**.
Ms. Wilson, "How can we divide it up so that it would work?"
A student, "Divide it up into three sections."
Ms. Wilson, "If we divide it up into three sections how can we label them?"
Another student tells her, "**B**, **A**, **A**."

The grid is divided in the following manner:

(insert the completed grid of Maze 1 Act. 6 from answers in the back of the unit)

9:09
Ms. Wilson continues, "What is the probability of getting into room **A**? Give me a denominator. All of my fractions have to have the same denominator."
A student says, "Thirty-six."
Ms. Wilson, "Right, how did you get that?"
A student, "I multiplied 6 by 6."
Ms. Wilson, "The reason he multiplied 6 by 6 was to give him thirty-six squares like we have on the grid. We could have just counted them. Now, how many **A**s are there?"
The students, "Fourteen."
The teacher, "How many **B**s are there?"
The students, "Twenty-two."

Ms. Wilson writes on the overhead projector:

$$P(\mathbf{A}) = \frac{14}{36}$$

$$P(\mathbf{B}) = \frac{22}{36}$$

As Ms. Wilson questions the students she waits a while so that most of the students have a chance to respond. In other words, most of their hands are up before she calls on a student for an answer.

Ms. Wilson says, "Right, so what is the most probable?"
The students tell her, "**B**."
Ms. Wilson, "All right, now you would choose that route."

(11/21/85)

Marsha's presentation of the second Maze in Activity 6 was the same as the one above. Although she involved more students by waiting for most of them to respond before she called on a student she did not provide many opportunities for them to work the mini-challenges on their own.

When the students were engaged in the EXPLORE phase of an activity Marsha usually acted as a monitor or facilitator as they worked, she did not pose additional thought-provoking problems or questions for consideration. Marsha's primary instructional goal for this phase seemed to be one of letting the students gather the data, rather than to think about the ideas behind the activity. A description of the exploration in Activity 6 illustrates how Marsha guided the students through this phase.

9:28

Ms. Wilson, "You have two hats and four marbles, two red and two white. What are the possible number of different ways you could arrange them? Think about the different ways we can arrange four marbles in two hats. What can we do here in the first one?"

Ms. Wilson has a transparency of Act. 6-1 (Which is Best?) on the overhead projector.

(insert Act.6-1, --reduced--Which is Best?)

Ms. Wilson continues, "We can put one red one and two white ones in one hat. What is the possibility of getting two red ones and two white ones?" She tells the students that if they had two red in one hat they could have two whites in another hat. In hat #1 they could have two reds and a white and in hat #2 a white."

Ms. Wilson set up problems #1, #2, and #3 for the students on the overhead. She tells them she wants them to work through #4 and #5 on their own. She gives them a moment to get started.

9:32
The students just started on #4 when Ms. Wilson interrupts them.
Ms. Wilson says, "All right, let's get started on this. What would be another one for number four?"
A student tells her, "You could put all of them in one hat."
Ms. Wilson, "What about down here?" (She points to #5)
A student, "You could put a red and white one in hat 1 and a red and white one in hat 2."

(11/21/85)

During the explore phases Marsha never let her students "struggle" with a mathematical problem or challenge on their own. If they had difficulty she would help them with the answer individually or she would stop the explore phase and work with the whole class.

The SUMMARY phases of the activities usually included the presentation

of data the students collected during the explore phase and a brief discussion of the outcomes. Although Marsha talked about some of the ideas included in the unit, she did not focus the students' attention on the bigger mathematical ideas embedded in the unit. On most occasions Marsha ended an activity at the end of the class period, this usually resulted in the summary phases of the activities being seriously curtailed. An example of this type of situation occurred in activity 6. The students were given five minutes to analyze their five different area models which had already been completed as a group (Worksheet 6-1). Since several students had difficulty with the fourth area model Marsha called the everybody's attention to the front of the room and began to summarize the activity.

9:40
Ms. Wilson, "Let me talk about this one (number 4) where we had to cut it in half. Hat 1 and Hat 2 works pretty good. Now, how am I going to divide up eighteen pieces into four parts?"
A student explains, "You have to take the first row and cut the second row in half."
Ms. Wilson, "So, we could have 4 1/2 squares in each of the four parts. So, what is the probability of getting a white? We still have 36 pieces. What's the probability of getting a white? It must be 9/36. Then what is the probability of getting a red?
The students answer, "9/36."

Ms. Wilson, "All right, let's go on to number five. What did you get for that one?"
A student tells her, "18/36."

Ms. Wilson, "What did you get for problem 3?"
A student says, "12/36 and 24/36."
Ms. Wilson points to problem 3 and tells the students, "If you had this arrangement you would have the greater probability of drawing a white marble. Now, because of the time I want you to just put your papers in your folders."

The bell rings and Ms. Wilson dismisses the students.

(11/21/85)

The activity ended with the ringing of the dismissal bell. Marsha did not review the outcomes or ideas with the students on the following day. This was the usual instructional pattern she had established for teaching of the Probability Unit.

When asked to identify the changes she made in her usual instructional style as a

result of teaching the Probability Unit, Marsha noted,

> "I usually pre-test and posttest, so that wasn't new. I also have different seating arrangements so that wasn't new. I have always discussed a lot with the students, so thast wasn't new. I did wait for more hands and tried to get more of the students involved than I usually do."
>
> Anne:
> "What made you do that?"
>
> Marsha:
> "After talking with my daughter last summer (Marsha's daughter was one of the students who participated in the MGMP Summer session) I said to her, 'Well, why didn't you raise your hand in class?' She told me, 'There were other kids there that knew the answer, so I just let them answer.' I figured if I wait till all the hands are up I can get more students involved."
>
> Anne:
> "Did you notice any difference in their answers?"
>
> Marsha:
> "I got more answers and ones that were different. The students could buy into two different answers instead of just accepting one. If I call on the students who are always right the rest of the class would change their answers to agree with them. The students had more freedom to be themselves and weren't intimidated by it."
>
> (1/8/86)

The only change Marsha noted in her usual teaching style was in the amount of time she waited for students to respond to her questions. She attributed this change to a comment made by her daughter.

Marsha was also asked to identify anything in the Probability Unit that she thought would transfer to her teaching of other units. Marsha noted she thought she would like to see more student involvement in the lessons,

> "I already do a form of launch and a form of a lab or experiment and I do a recall already--or a summary. I think I would do more of the discussion in the launch--open discussion, the interchange between the students and myself.
>
> I became aware of the feedback. I had done some of that but getting as involved in it as I was in this unit made me more aware of it."
>
> Anne:

"Was that because of the Student Talk portion that was in the unit's script?"

Marsha:
"Uh-huh. When the students really got involved in it. Especially when they took off on the dungeons and dragons. When they took off on that and how involved they got with it, and some of them were seeing into some of the things I was trying to teach. I would like to see if I can get more of the students involved in my regular classes."

(1/8/86)

Marsha related the LES model to another instructional model she had used for many years. She learned about this model (introduction, lab, wrap-up) in a course she took as a graduate student. She saw no difference between these two models. The one thing Marsha thought she wanted to do when teaching other units was to engage the students in more discussion.

Teaching the Transfer Task on Statistics:

The Transfer Task immediately followed the Probability Unit and was the continuation of a mini-unit Marsha started as a break between Activity 5 and Activity 6 in the Probability Unit. Marsha reported finding a chapter in an old 8th grade math textbook that contained the ideas and materials she wanted to use for her Transfer Task. The textbook's graphs and data served as the materials Marsha used for the launches. She used her own ideas for the explore phases. Throughout the teaching of the Transfer Task Marsha was enthusiastic and seemed to enjoy each activity.

Marsha wrote the activities of the Transfer Task in the LES manner. The problems and materials for the launches set the stage for the activities in the explore phases. For example, if the students were asked to calculate the mean and find the mode and median from data collected in an explore phase, then Marsha provided a similar activity in the mini-chalenge in the launch phase. The statistical concepts she wanted the students to understand were highlighted in the launches and reviewed in the summaries. Of the three phases of the LES model, the summary seemed the weakest, the length of

the summary was still determined by the amount of time left at the end of the period. Marsha spent more time discussing the ideas and relating the students' results to the mathematical concepts in the Transfer Task than she did in the Probability Unit.

The following observational segment from the Transfer Task illustrates the increased amount of time Marsha spent in discussions with her students. In this segment they are talking about the terms census and sample.

9:00
Ms. Wilson, "Remember yesterday we were talking about the different results that we got from our research? Remember when we polled the people? We have two words to add to our vocabulary list."

Ms. Wilson writes of the chalkboard:

census
sample

A student says, "I know what a census is."
Ms. Wilson, "What is it?"
The student, "It is when you take all the people."

9:02
Ms. Wilson, "Class, yesterday did we take a census or a sample?"
A student, "A sample."
Ms. Wilson, "Why?"
The student, "Because we only took part of the people that we looked at."
Ms. Wilson, "Right. Now, what is a census?"
A student, "A count."
Ms. Wilson, "What else?"
Another student, "A count of the whole thing."

9:04
Ms. Wilson, "Right, it is an examination or a count of everything that is studied. If we decided to take a census of the people in Activity 5 (Probability Unit) what would we have to do?"
A student, "You would have to ask everybody."
Ms. Wilson, "Right, and that might be too many people."
A student, "Well, you could take a census of a classroom."
Ms. Wilson, "All right. When would a sample be beter than a census?"
A student, "When you have more than sixty people."
Another student, "When it covers a large area."

Ms. Wilson, "How about if a doctor says he wants to take the statistics

of your blood--would he take a census?"
The students, "No!--he would take a sample."

A student, "Well he could take a census on your blood, because they could freeze you and take all your blood out."
Another student, "You've been watching science fiction too long!"

Ms. Wilson, "What about testing the soil for acidity?"
A student, "You would need a sample."
Ms. Wilson, "Why would a sample be better?"
The student, "Because a sample would be a part of the soil."
Ms. Wilson, "Would it be possible to take all the dirt?"
The students, "No."

(12/3/85)

Marsha encouraged much more student participation in her Transfer Task than she did in the Probability Unit. She also seemed better prepared for instruction during this unit than she was in the Probability Unit. Marsha seemed much more confident with the content, discussions, questions, activities, mathematical concepts and generalizations in this material. Marsha made the following comments relating to the Transfer Task:

Anne:
"Do you have any comments on the Transfer Task?"

Marsha:
"I enjoyed doing that one. I haven't done much on probability or statistics. In probability I usually would hand out a package of cards and then some dice and other materials and they would do some labs. I had not done anything with a launch and recall (summary). Doing it this way with the probability and statistics just made it more interesting for me--an more meaningful. It is the first time I followed my probability up with statistics, I could see for myself more of a fit between it and the probability. I figured if it means this much to me, then it means the same for the students.

"There is another thing that doing this unit has helped me with. It has made me aware of the amount of wasted time."

Anne:
"Tell me more."

Marsha:
"I have 47 minutes to teach these youngsters and I used to take attendance which took part of that time. Then at the end of the class, of we would finish early we would play games. But I became more aware of how much time I

> was taking from the students by taking attendance, shuffling papers, and passing out books. I have become aware of that."

By the end of the first semester, Marsha began to see how some mathematical units could fit together, began to organize her class time better (using student aids, math folders, etc.), and started to increase the quality and quantity of student-teacher interactions.

Summary:

Analyses of the pre-project observations and the first semester observations indicated Marsha was an exemplary middle school mathematics who had established patterns of communication and organization that promoted the presentation of the mathematics content and enhanced student learning. Marsha felt she understood the goals and objectives of the LES model because she related it to an instructional model she was using already. She introduced the daily topic or activity (launch), assigned a student task (explore), and reviewed the results (summary). She did not understand the differences between her model and the LES model.

Marsha began her lessons by telling the students what content they would be covering -- she rarely set the stage by posing a problem or telling a story. She typically demonstrated or modeled what needed to be done on the daily assignment and then engaged students in questions about the task or activity. Although she provided controlled practice problems for the students, the purpose for them was to provide practice rather than to develop ways to think about the mathematical problem or concept. Posing the main challenge for the students consisted of Marsha giving directions for the assignment. As a result, the students knew what their task was and how to do it, but they had little idea of how the activity would further their understanding of a mathematical concept.

As students started their assignment, whether in small groups or alone, Marsha's activities included: Keeping students on task, checking to see they were working problems correctly, and answering routine questions. Even when the students were as advanced as these were, Marsha seldom provided the opportunity for extra challenges that would have pushed their thinking. In Activity 6, for example, the students wanted to design their own mazes -- but Marsha gave this as an optional assignment.

Although Marsha reviewed the results of the daily activities with her students, her summaries still fell short of providing students with a better understanding or awareness of the mathematical ideas. She curtailed many opportunities for good summaries because she responded to the students' push to move on to another task and because she chose to end an activity when the period ended.

Marsha believed that the learning of mathematical concepts was achievied by working through a mathematical activity or task, not when the results of such activities or tasks are discussed, reflected upon, and linked to larger mathematical concepts.

III. Middle Grades Mathematics Project: The Second Intervention Year

This is a report of Marsha's participation in te MGMP during the second intervention year. This section is divided into four parts which are similar to those in the previous section. The first part is an overview which contains a description of the second MGMP summer workshop. The second part describes the MGMP Probability Unit Marsha taught during the first semester of the year. The third part discusses one of the three Transfer Tasks Marsha planned and taught to her students. The final section is a summary of the changes Marsha made in her instruction during the second intervention year and considers her implementation of the LES Instructional Model in regular mathematics lessons.

Overview:

Marsha attended the second MGMP Workshop for two weeks in the summer. At this time she joined the other MGMP teachers (coached and uncoached) to: 1) observe the teaching of the two MGMP Units, Probability and Similarity to another group of middle school students; 2) participate in an overview of two additional MGMP units, the Mouse and Elephant and Factors and Multiples; 3) take part in the discussion and feedback sessions after the instruction; 4) work with other teachers to plan a Transfer Task on fraction concepts to be implemented during the first semester; and, 5) read selected literature. Marsha thought the second summer workshop was much better than the first. In the following interview segment Marsha discussed her feelings about the experience.

> Anne:
> "When you think back to the summer workshop, of the five activities you participated in which seemed the most valuable?"
>
> Marsha:
> "I really liked working on our own Transfer Task. It gave me some ideas on how to get started and what to look for. I really liked that. It was probably the most beneficial to me. Watching the Probability and Similarity units being taught again after I had already taught it was very interesting to me. I remembered where I had trouble and it helped me to watch what they did with that same thing. I thought

> the discussion sessions afterwards were much more beneficial than last year. Probably the least beneficial to me was the readings."
>
> (5/13/87)

Marsha's feelings about the activities in the second summer workshop were different from those of the first summer workshop. She felt the most valuable activity of the second workshop was the collaborative planning of a Transfer Task--an activity she chose not to participate in the first summer because she felt very intimitated by the assignment. Secondly, she reported she liked watching the same MGMP Units being taught again because it gave her a chance to reflect on what she had done and sompare it with another teacher's instruction of the same material. Marsha said she plannned to study the questioning techniques of the instructors in the summer workshop so she could learn how to ask better questions when she taught the units herself. Since Marsha was an uncoached teacher, this activity probably came the closest to the "reflective-feedback" experience shared by the coached teachers and their coaches. Finally, Marsha felt the discussion sessions the second summer were more valuable because they were more focused on specific topics and were closely related to the observations of the classes. In summary, Marsha's participation in the second summer workshop seemed to be a much richer and more meaningful experience than the first.

It should be noted here that while the MGMP staff and teachers met as a whole group periodically throughout the project's two intervention years to discuss their instructional activities and other issues, Marsha attended only one of these meetings. So, her interactions with the teachers in the project were limited to the two other uncoached teachers in her own school. Therefore, her summer workshop experiences were the only chances she had to aquire an understanding of the LES instructional model and the conceptual orientation of the MGMP units.

The Marsha's target class for the project's second intervention year was very similar to the one observed the previous year. The students were sixth graders who were above average in mathmatical ability and attended Marsha's advanced math class. These students left their self-contained sixth grade classrooms to go the Marsha's room. The class

period was 45 minutes long. With the exception of a few more storage boxes for manipulatives and MGMP materials, Marsha's classroom remained the same since last lear.

Teaching the MGMP Probability Unit:

Marsha began teaching the Probability Unit in mid-October. She did not pause between Activity 5 and 6 this year to give the students added instruction in statistics. She taught all the Activities in the unit, but again as last year, she did curtail some of the games she felt were repetitious for her students. Marsha's instruction of the Probability Unit this second year was different from the previous year. Probably the greatest change occurred in her assuming a kind of ownership for the unit and it's instruction . She seemed much more comfortable with teaching the Activities and while she followed the script more closely this year she also took more liberties in changing the story lines in the launches.

The following is a section of the observational notes made on the day Marsha introduced Activity 6. She changed the story in the launch from the Princess and the Dragon (last year) to a game of Dungeons and Dragons.

> 9:51
> The students are entering the classroom and are taking their seats. Ms. Wilson has the overhead projector on with the transparency of the first maze in Activity 6.
>
> She begins the lesson, "Folks, today we are going to play Dungeons and Dragons. We are going to place our dragons in one of these areas and we are going to place our gold in another.
> Ms. Wilson has a small coin on the transparence to represent the gold and is using another small figure to represent the dragon.
> She continues, "You are going to play against me. You need to tell me where you are going to put the dragon and where you are going to put the gold so I won't get the gold. You don't want me to get it do you? Where is the room that would give me the least chance to get the gold?"

(insert Activity 6 -- Maze 1 (reduced) here
do not insert the grid)

The students tell Ms. Wilson to put the gold in area **A** .
Ms. Wilson, "How many of you vote for area **A**?"
Most of the students' hands are raised.
Ms. Wilson, "How many of you would vote to put the gold in area **B**?"
A few hands are raised.

Ms. Wilson, "We are going to have to make a decision each way -- how many decisions do I have to make?
A student, "If you rolled a one or a two that would be the upper path. If you rolled a three or a four that would be the middle path. If you rolled a five or a six that would be the bottom path."
The student is telling Ms. Wilson how she could use outcomes on a die to determine the path to take.
Ms. Wilson, "How can I divide this grid to show the choices?"Ms. Wilson has the following grid on the overhead:

(insert the grid on Maze 1--Materials 6-1--reduced--here)

A student, "Divide it into three parts."
Ms. Wilson, "I have 36 pieces and I want to divide it equally so how many will I need for each part?"
The students, "12."
Ms. Wilson, "So, I have 12, 12, and 12."

9:56
Ms. Wilson, "Let's try this." She rolls a four. "I got zapped right away! Let's play again." She rolls a six. "Now, what do I do?"
A student, "You have to make another decision."
Ms. Wilson, "Now, what do I do? How do I divide up my grid? I have 12 squares in this part. How am I going to divide that up? See, I have three choices to make." She continues dividing the grid.

(insert another Materials 6-1 grid --reduced--here)

A student, "Divide it up into four squares each."
Ms. Wilson, "This then would be **B**, **A**, and **A**. There is one group we didn't analyze yet and that is the middle one. What would happen in the middle one?"
A student, "You would get zapped because it goes to **B**."

Ms. Wilson, "Let's look ath the grid and analyze the problem. How could we use squares to show the probability of getting into room **A**? Does someone have any clues? (Nobody responds) Think about the grid--- How many of those are **A**s? What is the probability of getting **A**?
A student, "Fourteen-thirty-sixths."
Ms. Wilson, "What is a lower fractiion?"
A student, "Seven-eighteenths."

Ms. Wilson, "What is the probability of getting into room **B**? Isn't that twenty-two-thirty-sixths? What does it go down to?
A student, "Eleven-eighteenths."

Ms. Wilson, "You did pretty well, you put the dragon in room B, so that was good. You really chose the best place."

(10/28/86)

Marsha changed the story line of the activity to one that interested her students and she changed the way in which she discussed the analysis of the problem. The students were asked questions that made them respond by giving more explanations. Marsha continued in this mode of instruction for the second maze. Marsha told the classroom observer she felt more comfortable with teaching the probability unit this year than last year. One reason was because she was more familiar with the content of the unit the second time around. Another reason she gave was she felt she knew more about how the students would react to the unit.

She noted that she enjoyed teaching this unit more this year. Her enthusiasm was evidenced in the observations of the activities.

During the explore phases of the activities Marsha let the students work more on their own and deal with the problems as much as they could. This was in contrast to her actions last year when she continuously guided the students through each activity. During the explore phases of the activities Marsha walked around the room and monitored the students. When students asked her questions she asked them to explain how they were thinking about the problem or she would elicit their suggestions for a solution. During the observation of Activity 6, Marsha works through the first problem with the students then has them work the rest by themselves.

10:22
Ms. Wilson, "Let's try putting four marbles in two hats. You and your friend are playing a game and you lose if you get a red one. Let's go through one together."
A student, "Put one white marble in one hat and two reds and a white in the other."
Ms. Wilson, "All right, how would we divide up the grid?"

Ms. Wilson has a copy of the worksheet on a transparency on the overhead.

(insert Worksheet 6-1 -- reduced--here)

A student, "First you would divide it into thirds."
Ms. Wilson, "Right, one hat has to go into thirds, but what do I do with the first hat?"
A student, "You take the first hat and that is just half the grid."
Ms. Wilson, "Then there is a W in the first hat and the other one is thirds. How do I mark it?"

A student, "With a W, R, and R."
Ms. Wilson, "What is the probability of getting a white marble then? That would be twenty-four thirty-sixths. What is the probability of getting a red marble?"
The students tell her, "Twelve thirty-sixths."
Ms. Wilson, "And that reduces to what?"
The students, "Two-thirds and one-third."

10:27
Ms. Wilson, "You do the others by yourselves.
The students start working on the rest of the four arangements while Ms. Wilson walks around checking their work.

10:36
Ms. Wilson looks at the clock and tells the students they will finish these tomorrow, then she dismisses them.

(10/28/86)

Marsha's discussion with the students of the arrangement of two marbles in two hats (the observational segment is not included here) which was followed by an example of the arrangement of four marbles in two hats provided sufficient instruction so the students could work on their assignment with little difficulty. One change in Marsha's teaching of the Probabiity from the first year to the second was in the amount of time she gave to each activity. Last year, each activity was given one day to be completed. This year, Marsha did not let the length of the period dictate the length of the activity, the activity now ended when she felt the students understood the main idea of the lesson. Activity 6, above took one and a half days for Marsha to finish in the second year.

The summary phases of the activities during the second intervention year were longer and more focused on the mathematical ideas in the Activities. The following observation of the summary from Activity 6 illustrates how Marsha engaged the students in thinking about the probabilty ideas and about fractions as well.

9:50
The class is about t begin. The students are n the room and have picked up their math folders from the back of the room. Their Activity 6 worksheets are out on their desks. Marsha walks up and down each aisle checking to see that the students have completed their assignment.

Ms. Wilson, "Your sheets look prety good. I am going to go over these on the overhead and I want you to make any necessary corrections on yur

papers. This isvery important because I want you to compare yours with mine. It is more important for you at this time to understand and look at the correct answer than for you to just mark off the wrong answers and not correct them." Marsha puts the worksheet from yesterday on the overhead (Worksheet 6-1). She continues, "Remember yesterday you had four marbles in two hats? What were some of your combinations?"

The students give her their combinations and Ms. Wilson records them on the transparency.

9:55
Ms. Wilson, "Let's go through these and shade them in. What does the grid represent?"
A student, "The marbles."
Another student, "The sections."
Ms. Wilson, "What is this going to tell us at the end?"
A student, "The probabilities."
Ms. Wilson, "So, why do we divide the first into equal parts?"
A student, "Because you have two hats, two halves."

Ms. Wilson marks each of the five grids in half.

Ms. Wilson, "Now, let's go back and figure this out for all the choices. Remember what we wnat is the highest probability. Do you agree?"
The students, "Yes."
Ms. Wilson, "Now, for the first one we have this."

HAT 1	HAT 2
W	W
R	R

Ms. Wilson continues, "So then we have how many whites?"
A student, "Eighteen."
Ms. Wilson, "What is the probability of getting a white?"
A student, "Eighteen thirty-sixths or one-half."

Ms. Wilson, "What is the probability of getting a red marble?"
The students, "One-half."

Ms. Wilson, "What is the next one?"
She draws the following on the transparency.

HAT 1	HAT 2
W	R
W	R

Ms. Wilson, "What is the probability of getting a white?"

The students, "One-half."
Ms. Wilson, "What is the probability of getting a red?"
The students, "One-half."
Ms. Wilson, "Is that a good choice?"
The students, "No."

Ms. Wilson, "We have the next one here."

HAT 1	HAT 2
R	W W R

Ms. Wilson, "What could we have for the probability of getting a red?"
A student, "Twenty-four thirty-sixths or two-thirds."
Ms. Wilson, "What is the probability of getting a white?"
A student, "Twelve thirty-sixths or one-third."
Ms. Wilson, "Is that a good choice?"
The students, "No."

Ms. Wilson, "Let's do the next one."

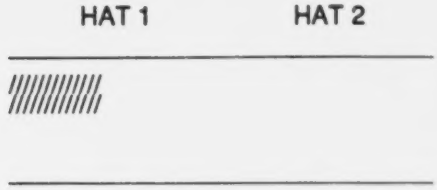
HAT 1	HAT 2
W	R R W

Ms. Wilson, "What is our denominator?"
The students, "36."
Ms. Wilso, "How many whites do we have?"
The students, "24."
Ms. Wilson, "How many red ones?"
The students, "12."
Ms. Wilson, "So, that reduces to what?"
The students, "Two-thirds and one-third."
Ms. Wilson, "Is that the best choice?"
The students, "Yes."

Ms. Wilson, "I wonder about this one. In hat 1 we are going to have to divide it into four parts."

HAT 1	HAT 2
R R W W	

She points to the upper left quadrant of the grid:



She continues, "Tell me, could I make the whole thing red?"
The students tell her, "Yes."
Ms. Wilson tells the students that although there are two red marbles in this quadrant since both of them are red the quadrant would be red.

Ms. Wilson, "Could I make the bottom section white? What would I do with the nine pieces in that quadrant to cut them in half?"
A student, "You could divide 9 by 2 and get 4 1/2. Shade in four and a half squares."
Another student, "You could just draw a line right down the middle of the square."
A third student, "You could draw a diagonal."

10:05
Ms. Wilson, "Well, then what do we have? We have an empty hat here. Half of it is empty. What would be the probability of getting a red marble."

The students look at the grid.
A student says, "One-fourth."
Ms. Wilson, "What is the probability of getting a white?"
A student, "One-fourth."
Ms. Wilson, "Can you order these from the best choice to the slimmest?"
A student, "Yes. The best choice would be two-thirds."
Ms. Wilson, "So we have from one-fourth which is the worst possible choice to two-thirds which is the best."

Ms. Wilson works through each of the grids and shows the students the relationship between 1/4, 1/3, 1/2, and 2/3 by counting the number of squares in each section. She asked the students which would be the better choice, 1/3 or 1/4, when they couldn't answer she used the grid and asked, "Which one had the better chance or the greater number of squares."
(10/29/86)

The summary of Activity 6 took 16 minutes provided the students with a review of the probability concepts and some fraction ideas as well. Marsha reported to the observer she preferred to launch and explore an activity on one day then summarize it the next. This was a change from her thinking about teaching one activity per day last year.

Marsha's instruction during the Probability Unit this year was different from

last year. She was much more comfortable with the content and the script than she had been. She improvised many of her own stories for the launches and spent more time questioning and engaging the students in controlled practice activities. During the explore phases Marsha acted as more of a facilitator, guiding the students as they worked on their activities. She did not spend as much time this year in telling the students the correct answers or results during the explorations. Finally, she spent more time in summarizing the ideas of the activities and was not constrained by the amount of time needed to finish this task. Many activities took Marsha 1 1/2 to 2 days to go through this year. Last year Marsha saw the linkage between the Probability Unit and the Statistics Transfer Task she taught -- this year she noted the importance of the unit in reviewing other mathematical content such as fractions, decimals, and percents.

Teaching the Transfer Task:

Marsha taught three Transfer Tasks uring the second year of the MGMP intervention. The first Transfer Task she taught in the fall was the unit she planned with a group of MGMP teachers during the summer workshop. In an interview she reported feeling uncomfortable in teaching that unit.

> "The first Transfer Task on fractions I thought was going pretty well when I was working with the students. I gave them a pre-test that we had written and when I gave them the post-test I found out they didn't do much better. I was real disappointed. That's where I felt they had really understood what I was talking about, but I then realized I hadn't been able to bridge the gap from what I was doing in front of the class with my hands to down here on the students' papers. I hadn't made that linkage. I felt the second fraction Transfer Task on problem solving went much better."
>
> (5/13/87)

Marsha's believed her second Transfer Task on fractions was more successful than her first. She reported, "I enjoyed doing that one. In fact, I had taken that idea and I am doing story problems with my algebra students, working in this kind of approach seems to be helping. All of a sudden algebra word problems weren't so bad for them." (5/13/87) Marsha's strategy for planning the second Transfer Task was to select from a set of

commercially prepared worksheets on fraction word problems and to use two for the beginning of class activity, one for the launch, one for the explore, and one for the summary.

Marsha's plans for the second day of the fraction word problem Transfer Task are included below. She used worksheets on fraction word problems as materials for the activities. It is interesting to note the absence of written questions, extra challenges, and elaborations of the concepts/ideas.

DAY 2: TRANSFER TASK #2
Topic: Word Problems
Objective: 1) to estimate and use mental arithmetic
2) to set-up and work math problems from word-problems
3) to write word problems
4) to research, examine, and write-up data

(discuss and do a few problems)		1. MENTAL MATH
	Transparency	a. "Where's Your Head At?"
	Transparency	b. "In Your Head...Again?"
	Write on board	2. Discuss an approach to problem solving
		a. Understand the problem
		1. What is being asked
		2. What operation is needed
		b. Planning a Solution (drawings)
		c. Finding the Answer
		3. Doing Word Problems
LAUNCH	Transparency	a. "Picture Problems" pg. 1
EXPLORE	Transparency	b. "Picture Problems" pg. 2
	Dittoes	
SUMMARY		c. Go over pg. 2
	Do one or two	4. "Wordless Problems"
		5. HOMEWORK

(4/28/87)

The following launch from this lesson plan illustrates Marsha's use of questioning and controlled practice activities.

9:08
Ms. Wilson, "We are going to do some problem solving with fractions today. What are some things you can do to understand the problem?
A student, "Look for key words."

Ms. Wilson writes on the chalkboard:

Look for Key Words

Ms. Wilson, "For example, if I wanted to add what would be a key word I might look for?"
A student, "How many altogether."
Ms. Wilson, "What about if I wanted to subtract?"
A student, "How many are left."
Ms. Wilson, "What else could be either add or subtract?"
A student, "For adding you could have sum."
A student, "For subtract you could have difference."
Ms. Wilson, "What are the multiplication key words?"
A student, "Times."
A student, "Product."
Ms. Wilson, "If I say 1/3 of a number you usually multiply it. Let's see now. Division -- how would we find division?"
A student, "You might see the word quotient."
Ms. Wilson, "Right, and sometimes it just tells you to divide something equally among other things."

9:13
Ms. Wilson, "Let's take a look at problem #2. After we understand the problem what do we have to do?"
A student, "Plan a solution."
Ms. Wilson, "What's the key thing about finding the answer? Think about the anser and see if it is reasonable. Does that make sense? If you had this problem to do."
Ms. Wilson reads problem #2 to the students, "'A kilometer is about what fraction of a mile.'"

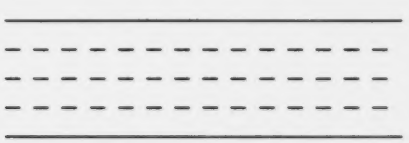
Ms. Wilson, "Look at this. What can I do?"
A student, "Draw your lines up and you would have the fraction three-fifths."
(4/28/87)

Marsha worked through problems 3 through 6 in the same manner she did in problem 2. The students looked at the transparency of the page and answered Marsha's questions regarding these problems. She did not ask the students to reword the problems and she did not ask the students any questions that might have extended their thinking about these problems. When the students completed the problems on the transparency, Marsha had them work together in small groups to solve similar problems 7 through 12 on the second page. From 9:21 to 9:32 the students worked on

their assignment while Marsha circulateed around the room to answer their questions.

At 9:32 Marsha began her summary of this activity.

9:32
Ms. Wilson, "Let's take a look at these problems and see what we can do with them. How many of you have an answer for #7? Liz, what do you have?"
Liz, "4,000."
Another student, "We got four-ninths because that is what they were asking."
Ms. Wilson, " How many got 4,000?"
Most of the students raise their hands.
Ms. Wilson, "How many have four-ninths?"
The students in one group raise their hands.
Ms. Wilson, "When I read that there were some key things I saw that 9,000 was visible and that 4/9 was seen from one spot on the earth. So, I have 4/9 times 9,000 and if I cancel I get 4 times 1,000 and that's 4,000. There was another key word there--**OF**. Here is another one that was hard. It is about a human hair. What did you get?"
A student, "1/60."
Another student, "1/000."
Ms. Wilson, "Do you want to see this one worked out? (The students nod their heads) It tells us that the human hair is 1/250 of an inch and the wool from a sheep is only 1/4 of a human hair. Let's start by drawing a human hair."
Ms. Wilson draws a long cylinder on the chalkboard to represent a human hair and then quarters it.



She continues, "How many parts do I divide it into to get 1/4? How much do I have to color it in to get 1/4?"
A student, "One slice."
Ms. Wilson, "So, that tells me that my bottom number has to be larger than 250. It says '1/4 of', so that tells me what to do. What would I do?"
A student, "Times."
Ms. Wilson, "So if you multiply it you would get the following."
She writes the problem on the chalkboard.

$$\frac{1}{4} \times 250 = \frac{250}{4} = 62\ 1/2$$

Ms. Wilson continues, "What did you get for #9?"

(4/28/87)

The summary of the activity continued in this same manner. Marsha asked the students to tell her their answers for the problems and if there were disagreements

concerning an answer she worked the problem for the students by drawing a picture followed by the calculation of the answer. My observational comments at the end of this activity summarized my thoughts about Marsha's Transfer Tasks at the end of the Second Intervention year.

> Observers Comments (4/28/87):
>
> In this activity it seems as though the teacher has some notion of the LES model, but it's not much different from her regular mode of instruction. Her launches are demonstrations of sample problems similar to those the students would receive for their assignment. Her explores are times when students work together on an assignment. Her summaries are used for checking assignments. Although Marsha has improved in the questions she asks students and in the ways she shows students how to solve problems, I believe her Transfer Tasks are more typical of her instructional pattern 2 years ago at the beginning of the project.

During an interview at the end of the project Marsha was asked to respond to some questions relating to her planning for and teaching the Transfer Tasks. Her respmse to the following question captures her thoughts about designing a Transfer Task.

> Anne:
> "If you were to do a Transfer Task on decimals next year, what would be the first thing that would come to mind?"
>
> Marsha:
> "The first thing I would think about is what do I feel is important that I want the students to understand when I am all through teaching it. Then I would look through the materials and see what I had that not only had practice problems on it but also showed the ideas. I would look into the textbook to see what they presented only as a last resort.
>
> Sometimes after I do everything else I go back into the textbook and see if I can apply what we've done. After I have found the material I would look for some ideas and manipulatives that I could use that would show that. Then I would find some things they could touch because they'd have to touch and feel it in order to put things together to show the ideas or concepts."
>
> (5/13/87)

Marsha's thoughts about planning for and teaching a transfer task began with the mathematical ideas/concepts she wanted the students to learn. From there she searched for appropriate materials to organize in such a way as to provide

the students with a launch and explore experience. Absent from Marsha's response were comments about how she would teach the new unit and how she would link this to bigger mathematical ideas.

Summary of the Second Intervention Year:

Analyses of the observational and interview data collected during the Second Intervention Year indicated that although Marsha had changed in some ways, her instructional mode remained very similar to that observed during the Pre-Project and First Intervention Year periods. Prior to the start of this year there were two project-related activities in which Marsha participated that had a significant impact on the changes she made during the second year. The Spring Workshop was the first opportunity Marsha had to interact with the rest of the project teachers since the previous summer. During an interview Marsha commented on the value of this experience to her.

> Anne:
> "With respect to the Spring Workshop, what was it's value to you in your thinking about your curriculum and your teaching for next year?"
>
> Marsha:
> "I thought it was great. Tremendous. In fact, the materials we got out of this meeting were really great. Probably the most valuable thing was the discussion we had about the topics we taught in our classrooms. It is one thing to look at a course outline in a textbook that some author has made up and it is another to really deal with it in your classroom. It was helpful to hear how other teachers deal with the same topics.
>
> (5/21/86)

The Summer Workshop also provided Marsha with her second chance to interact with the project teachers prior to the start of the school year. It also allowed her to work with a group of project teachers to design a Transfer Task. This was something Marsha had to do on her own during the First Intervention Year because she did not participate in the Transfer Task activity in the first Summer Workshop. Both the Spring and Summer Workshops gave Marsha the opportunity to interact with other teachers which she thought helped her think differently about her instruction. The differences in her thinking were in the nature of the mathematical content of her classes, interactions with the students, and

managing/organizing the classroom for better instruction.

Marsha thought differently about the mathematical content she taught. Although she reported she spent half the time teaching mathematical concepts at the start of the project, she now thought she taught more mathematical ideas than before. She said,

> "I stress concepts more now than I did. Especially teaching fractions, because I thought, 'Boy, if we could just memorize two things we would have fractions whipped!' But, the fractions ended up whipping us. Now we are doing much more of the pictorial."
>
> (5/13/87)

Marsha realized her students needed to draw representations of the mathematical ideas they were learning if they were going to understand them. She noted, "I had trouble bridging from the concepts when I did the fraction strips to actually applying it to problems, so what I am trying to do now is to have them (the students) draw the pictures first and see what happens.(5/13/87)"

Marsha became more aware of the kinds of interactions or communication that took place in the classroom. She studied how the Summer Workshop teachers asked questions of the students when they taught the MGMP Units and she used some of these techniques with her own students. Marsha talked of changing her patterns of communication during the year. She said, "I spend a lot more time with the concepts and talking to the students. I don't just go to the chalkboard and show them how to do a problem. (5/13/87)" In an interview at the end of the First Intervention Year Marsha talked about one questioning strategy she started to use.

> "Lots of times in the past when students would ask me questions I would say such and such was the answer, or have them do the problem again--the same thing I had already done. They still didn't understand. Now, when they ask me a question I ask them to show me what they have done. We'll talk about some of the things they may have tried that didn't work, or we might look for something in what they have done.."
>
> (5/21/86)

Marsha also realized the value of managing or organizing the classroom in order to promote the learning of mathematics. In addition, she began to recognize that good materials

without good instruction would not improve students' mathematics learning. In an interview Marsha was asked how she would work with other math teachers to help them improve their teaching of mathematics. Her reply was,

> "Well, I think teachers need to know how to fit things into their curriculum. Giving them a package of materials and say to them, 'Let's do this', I don't think will work. We need to show them how to break their math period into smaller bits and teach them how to do a little bit of this and a little bit of that each day. For example, for the first few minutes of the day they can review a concept while taking attendance by putting something on the board for the students to do. The last five minutes a day the teachers can give students a one problem quiz to see what they understand. Teachers also need some long term goals. Some management and pacing needs to be worked into a program. (5/13/87)"

Marsha spent more time during the class period in mathematical activities this year than she had in the past. Part of the reason was the use of instructional strategies that helped her become a better prepared and more organized teacher (e.g. the use of notebooks and a starting of class activity). Another reason was her selection of mathematical tasks that required more active student involvement and participation throughout the math period.

IV. Marsha Wilson's Instructional Change

This case study presented a portrait of Marsha Wilson's mathematics instruction during her two year participation in the activities of the Middle Grades Mathematics Project. This final section of the case study summarizes these instructional changes and discusses the limitations change as a result of her role as one of the Project's uncoached teachers.

What Instructional Change Occurred in Marsha Wilson's Practice?

Marsha's instructional mode was only slightly different from that which was first observed during the baseline observations. By the end of the Project she was spending more time with her students in direct instruction than she had in the past. She incorporated more questioning and controlled practice into this time. Although much direct-instruction remained teacher-directed, Marsha allowed and even encouraged more student participation. She asked students to describe their thinking and to give more detailed answers to her questions.The students still copied notes from the chalkboard or overhead projector to keep in their math folders for future reference. During the lesson assignment periods Marsha's instructional activities included checking on the students' progress, answering "procedural" or "how-to-do-it" questions from students, and keeping students on task. These teacher activities were unchanged from the baseline observations. While Marsha included more student groupwork than she had in the past, this seemed to be directly related to the MGMP units and did not become a part of her thinking about planning for other instructional units. There was no evidence from either the clasroom observations or interviews that Marsha consistently and habitually included structured groupwork activities in such a way that would promote the students' understanding of the mathematical concepts in the lesson. In addition, there was no evidence Marsha used the lesson assignment time to check for students' understandng of the mathematical concepts they were studying. At the conclusion of the Project Marsha was observed spending more time with the students in discussing the answers

to the daily assignment. She included more pictorial representations in her explanations of the answers than she had done in the past. In general, more class time was now being used in mathematical activities than had been done in the past. Although there were changes in Marsha's mathematics instruction and her thinking about teaching mathematics, in general these seemed to be mere modifications of an already established pattern of instruction.

In the first section of this case study three instructional areas were considered in the discussion of Marsha's classroom practices and her thoughts about teaching mathematics; these included communication patterns, organizational strtegies, and the mathematical task and content selection. These three areas will be revisited in this summary section in order to ascertain more clearly the places where instructional changes occurred or did not occur. The Teaching Style Inventory included two items that related to Marsha's thoughts about communication patterns in the math class. Her responses to these questions prior to her work in MGMP, after her first year, and at the end of the project (the second year) are included below:

TEACHING STYLE INVENTORY	Pre-MGMP	End of Year 1	End of Year 2	
2. When students have trouble, I ask them leading questions.	____	____	____	1
	____	____	__X__	2
	__X__	__X__	____	3
	____	____	____	4
When students have trouble, I explain how to do it.	____	____	____	5

and,

14. Almost all my questions in math class can be answered with a yes, no, or a number.	____	____	____	1
	____	__X__	____	2
	__X__	____	__X__	3
Almost all my questions in math class require the students to give explanations.	____	____	____	4
	____	____	____	5

Marsha's responses on these two items which considered the quality of mathematical communication did not change significantly across the two years she was involved in Project activities.

The students in Marsha's classes completed a Student Survey of the Classroom at the beginning and end of each school year. A comparison of their responses on the items that considered communication patterns in the classroom (Spring 1985, Spring 1986, Spring 1987) indicated no significant change across the two years. The survey scores reported below are classroom averages of the student responses. The students chose one of the following responses for each item: *Never, Seldom, Half the Time, Usually, Always.* For the purposes of calculating a class average for each item, the responses were assigned a number from 1 (Never) to 5 (Always). The following are the items and class averages for the Spring surveys.

STUDENT SURVEY OF THE CLASSROOM	Sp.'85 Pre-MGMP	Sp.'86 End of Year 1	Sp.'87 End of Year 2
2. Does your math teacher ask you questions that make you curious?	3.19	3.00	2.85
4. When your math teacher asks a question, do you have time to think about the answer before you must reply?	4.18	4.23	3.88
16. When you have trouble with a problem does your teacher tell you the answer?	2.32	2.13	1.93
17. When you have trouble with a problem does your teacher give you hints so you can figure it out?	3.09	3.16	3.37

The classroom averages on the items related to communication patterns across the three Spring surveys indicated little change in the students perceptions of Marsha's questioning and explaining strategies. There was more change in the students' responses in the classrooms where MGMP teachers received coaching by a staff member.

Marsha implemented several organizational strategies from the MGMP activities in her classroom. For example, the use of math folders to keep assignments and worksheets

was one idea she used from the MGMP Summer Workshop. A second organizational idea she used in her classroom which was the result of project-related work was to get the students started of a mathematical activity at the beginning of the class period. The different organizational strategies Marsha implemented as a result of her project work were not very different from her usual instructional practices. At the start of the project the baseline observations indicated she had many effective organizational strategies in place already. She used the students to help her hand out and collect materials and papers and grouped students on occasions for math activities. The new stratgies she now used were variations or refinements of those which she already had in place. Three items on the Teaching Style Inventory related to Marsha's perceptions of how she organized her students and her classroom for the learning of mathematics. Her responses from the pre-project survey to the second year survey indicated little change had occurred.

TEACHING STYLE INVENTORY	Pre-MGMP	End of Year 1	End of Year 2	
4. In class, students frequently work together on assignments.	____	____	____	1
	____	__X__	__X__	2
	__X__	____	____	3
Students seldom work together on assignments in class.	____	____	____	4
	____	____	____	5
5. When studying a math unit, students spend some time working in small groups to solve a big problem.	____	____	____	1
	____	__X__	____	2
	__X__	____	__X__	3
When studying a math unit, students will not be working in small groups to solve a big problem.	____	____	____	4
	____	____	____	5
10. The furniture arrangement is the same for every math lesson.	____	____	____	1
	____	____	____	2
	____	____	____	3
The furniture arrangement varies according to the lesson.	__X__	____	____	4
	____	__X__	__X__	5

In two of the three respnses (4 and 10) Marsha changed her thinking during the first year of the project and this change remained throughout the second year. It should be

noted that her responses on these two items moved in the desired direction as determined by the project staff. Important to note is that although there was some change it was not as great as the changes made by some of the other coached teachers in the project.

Three items on the Student Survey of the Classroom related to the organization of the students and the instruction. The responses of the students in Marsha's classes across the project years indicated a slight contradiction between Marsha's responses and their perceptions. As before, the responses are class averages using a Likert-type scale from *Never* (1) to *Always* (5).

STUDENT SURVEY OF THE CLASSROOM	Sp.'85 Pre-MGMP	Sp.'86 End of Year 1	Sp.'87 End of Year 2
18. When you have trouble are you allowed to ask other students for help?	3.05	3.03	2.20
19. Do you work in groups of 2 or more students during your math class?	2.68	3.13	2.56
20. In your math class are you supposed to work by yourself?	3.36	2.90	3.59

Interestingly, at the end of the first year of the project Marsha's students indicated more of a change on items 19 and 20 than the students in her pre-project and year 2 classes. They indicated that more than half the time they were allowed to work in groups and less than half the time they were supposed to work by themselves. These two responses supported Marsha's responses for the same time period (Year 1) for items 4 and 5 on the Teaching Style Inventory. However, by the end of the second year Marshha's students reported they were seldom allowed to ask other students for help, were supposed to work by themselves, and spent less than half the time working in groups. Their responses slightly contradicted Marsha's during this same time period. A comparison of the results of the Student Survey's of the coached teachers during this same time period, Marsha's students showed less change.

The pre-project observation, survey, and interview data indicated Marsha's thoughts about and practices in teaching mathematics were both conceptually and

algorithmically oriented. Marsha's responses to eight items on the Teaching Style Inventory related the mathematical content and tasks across the project's two years indicated that in some areas Marsha's thoughts had changed significantly. The items and her responses are included below:

TEACHING STYLE INVENTORY	Pre-MGMP	End of Year 1	End of Year 2	
6. I encourage students to solve a given math problem the way I have demonstrated.	X			1
				2
				3
I encourage students to solve math problems in a variety of ways.				4
		X	X	5
7. I present a math concept first then illustrate that concept by working several problems (deductive).				1
	X		X	2
		X		3
I present the class with a series of similar problems, then together we develop concepts and methods of solving the problems (inductive).				4
				5
9. When I teach a new topic, I spend a good deal of the time (1/3) trying to teach students to use similarities and differences between new and previously learned math ideas.				1
	X	X	X	2
				3
				4
New topics are generally taught with limited reference to previously learned math ideas.				5
11. In my math class I emphasize the basic computational skills three-fourths of the time or more.				1
				2
	X	X	X	3
In my math class I emphasize concept development three-fourths of the time or more.				4
				5
12. I seldom change my approach throughout the semester (such as lecture-discussion, discovery, etc.)				1
				2
				3
I change my approach frequently (from discovery to direct telling or from another method to something different) throughout the semester.	X			4
		X	X	5
13. Understanding why a given rule or procedure gives the correct answer is important.		X	X	1
				2
	X			3
				4
Understanding the rule or procedure is not critical.				5

TEACHING STYLE INVENTORY (continued)	MGMP	Year 1	Year 2	
16. I usually use a game, story, or challenging problem to provide a context for a new math unit.				1
		X	X	2
				3
I usually do not use use a game, story, or challenging problem to provide a context for a new math unit.	X			4
				5
17. I usually start a new math unit by giving examples and showing students how to work them.				1
	X	X		2
				3
I usually do not start a new math unit by giving examples and showing students how to work them.			X	4
				5

Four of the eight items on the survey (7, 9, 11, 12) showed little or no change in Marsha's thinking about the teaching the mathematical content or selecting the tasks. She continued to a) prefer a deductive approach in her teaching mathematics and b) help her students find connections between mathematical ideas; c) emphasize concept development about half the time; and d) change her instructional approach throughout the year. The remaining four items indicated she had changed her thinking during the first year of the project and sustained that change throughout the second year.

Two changes Marsha made in her thinking were in her encouragement of students to solve problems in a variety of ways and helping students understand why rules or procedures gave correct answers. The two remaining changes could to be attributed to her use of the MGMP Units since they related to the LES Instructional Model, that is: 1) the use of a game, story or challenging problem to set the context for a new math unit; and 2) not starting a new math unit by giving students examples of problems and demonstrating their solutions. Of the total number of items on the Teaching Style Inventory Marsha's responses on only these four items (6, 13, 16, 17) indicated a significant change (a change of 2 or more levels) in her thinking about teaching. The results of the Teaching Style Inventory substantiates both the interview and observational data in showing the lack of any great change in her instructional practice.

There were five items on the Student Survey of the Classroom that related to the mathematics content and tasks. The classroom averages for the responses (*Never*=1 to *Always*=5) across the project are included below:

STUDENT SURVEY OF THE CLASSROOM	Sp.'85 Pre-MGMP	Sp.'86 End of Year 1	Sp.'87 End of Year 2
3. Does your math teacher encourage the class to find different ways to solve the same problem?	3.91	3.74	3.83
5. Does your math class spend the whole period practicing computation?	2.32	1.81	2.29
7. Does your math class ever work on a problem for an entire period?	1.55	1.52	1.41
8. Does your math class ever work more than one class period on a problem?	1.23	1.23	1.17
21. Do you use things like blocks, spinners, or rulers in your math class?	3.05	3.32	2.61

In general, the results from the student surveys showed little chang e in the classroom from the students perspective across the three years. It was interesting to note the students responses on items 7 and 8 for the end of the first and second years of the project because they had, in fact, spent several days working on single problems from the MGMP Units and had taken more than one day to work on a single problems. Perhaps Marsha did not help the students realize that they were working to solve one big problem over this time.

In summary, analysis of the data collected in Marsha's classroom at the start of the project indicated that she was an exemplary teacher who was already teaching mathematics in a fairly effective manner. The project staff questioned at that time whether she could make any significant changes in her teaching practice. Of all the teachers who paticipated in MGMP, Marsha seemed to be one of the best. The analysis of the observations, interviews, and surveys at the end of the project showed that she did make some slight changes in her practice, but that overall no significant change occurred. She just got better at what she

was already doing well.

The Limitations of Marsha Wilson's Instructional Change

As an uncoached teacher, Marsha's opportunity for instructional change was limited to the information she received during the Spring and Summer Workshops and what she learned on her own from teaching the MGMP units. These activities caused her to think about her instruction and did have a limited effect on changing her teaching practice. However, the changes that occurred were far from the dramatic ones seen with the coached teachers. The following instructional changes were observed in the practices of the coached teachers but were not seen in as changes in Marsha's instruction. First, she did not apply the LES Instructional Model to her planning and teaching of regular mathematical units. Second, she did not consistently strive to make conceptual linkages between several units of mathematical content. Third, Marsha did not come to have a different (more holistic view) of the math curriculum. Fourth, her planning for new units of content did not begin with a clear understanding of the mathematical ideas and goals she wanted to the students to obtain. Finally, she did not become more reflective of her own instruction as a result of her participation in the the project. It is likely these kinds of changes could have occurred had Marsha had the opportunity of being coached in her classroom.